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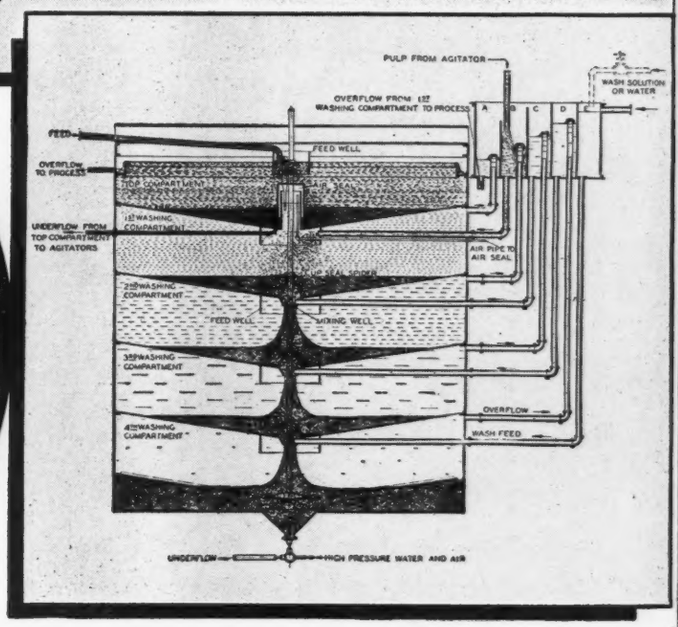

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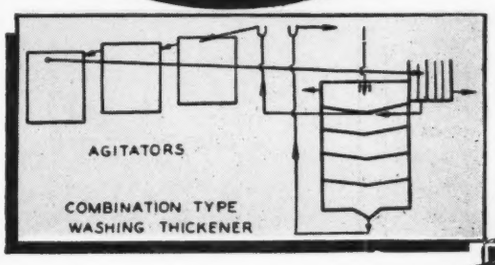

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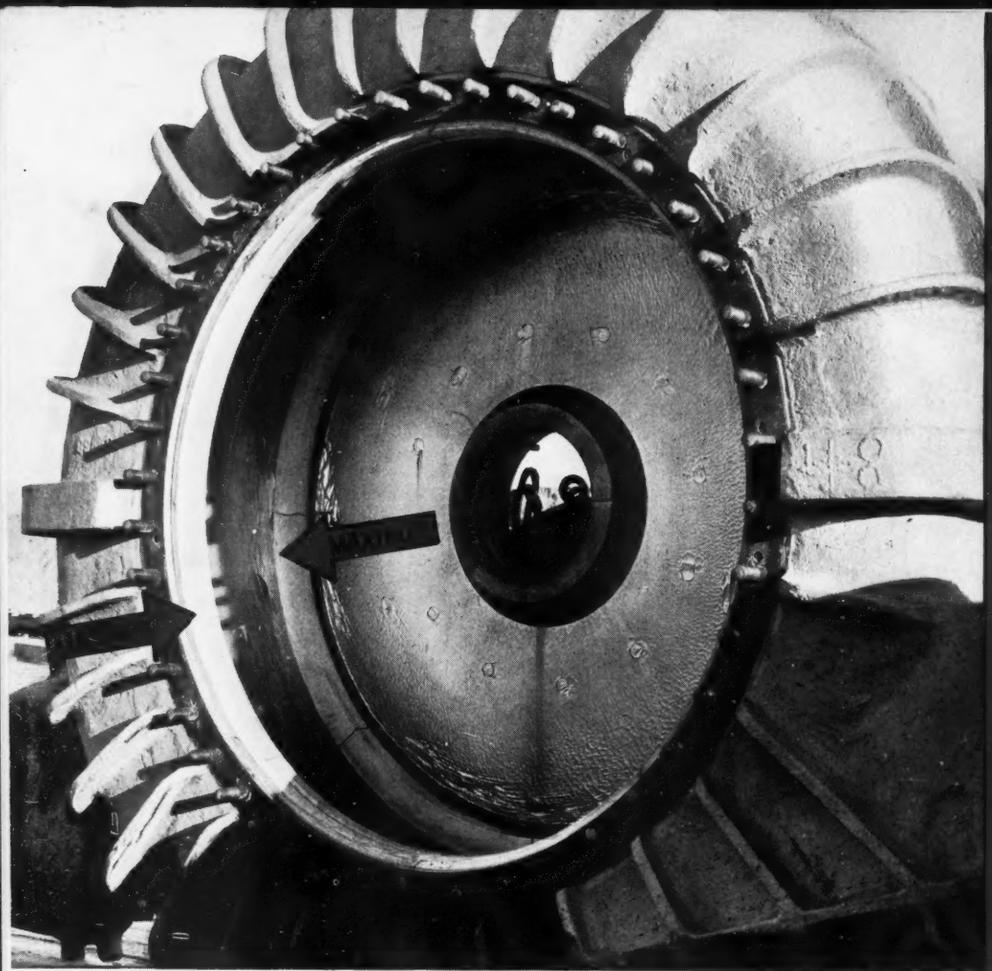

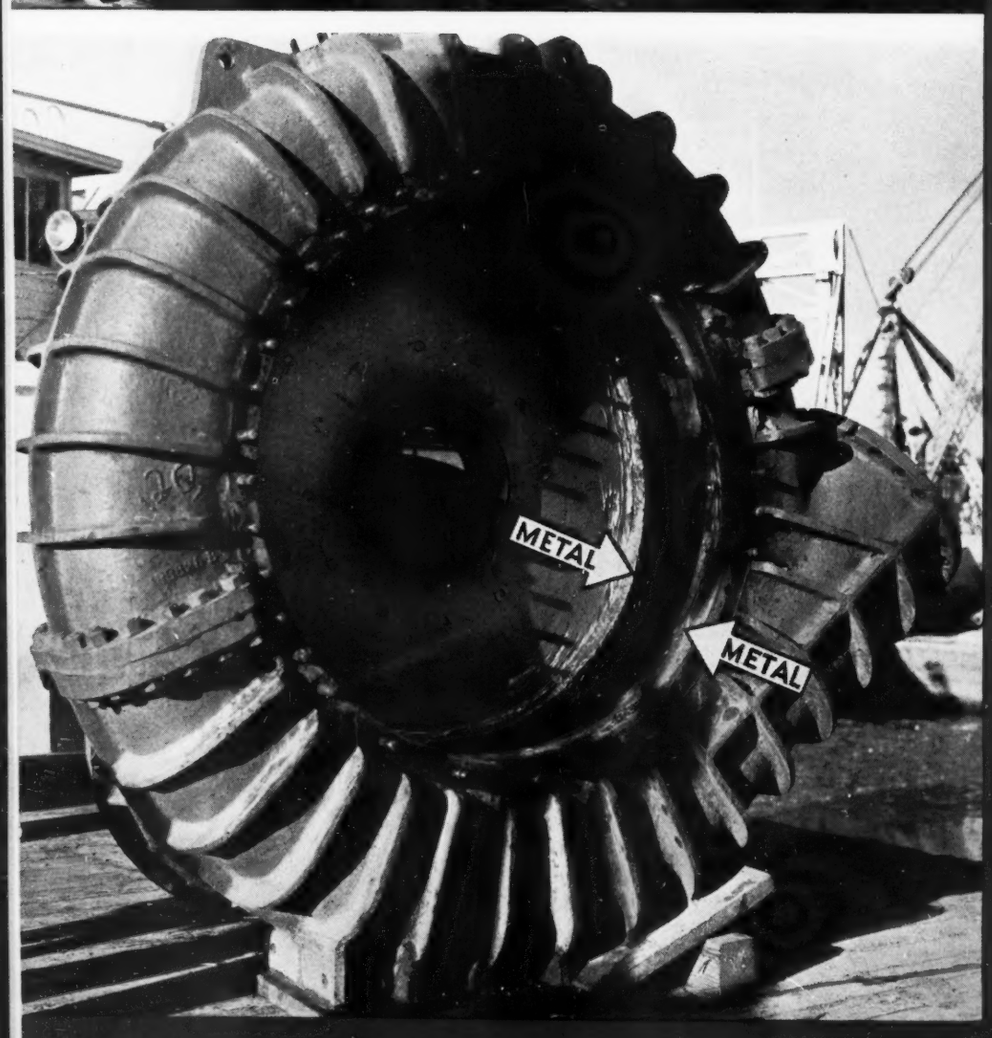

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Soviet Copper. Production of blister from ore and scrap amounted to 75,429 metric tons in 1935, according to American consular reports to the Department of Commerce. This is said to be about double the output in 1930. In spite of this progress, however, copper production in the U.S.S.R. is so far behind demand that 30,000 tons of metal was imported in 1936. Three copper-smelting plants are now operating in the Ural Mountains.

▼

A Tin Dredge, capsized in the English Channel while en route to the Dutch East Indies, is still upside down, according to report, no harbor deep enough for grounding it being near at hand and the ocean being too deep for mopping up. But when Natomas No. 8, gold dredge of California, sprang a leak and sank in 60 ft. of water, turning over on its side, the company pumped out the pond and righted it with wire rope lines and winch, prior to dismantling and junking it. The story will be told in the June issue by Cyril Thomas.

▼

The Bureau of Standards has taken its research to the race track, where it has made a critical study of the "camera finish," in particular taking up the hypothesis that the camera favors the outside horse. It finds that adverse criticism has been based on certain alleged errors in judging the first horse, whereas these admitted small errors can occur only in a connection with the placing of the second and third. Thus science and sport go hand in hand.

▼

Yellow Fever, once thought practically eliminated as a human menace, is still cause for serious concern, according to a review of the work of the Rockefeller Foundation in 1936. An endemic type of the disease can and does occur in districts free of the *Aedes aegypti* mosquito. There is another unknown villain or villains than this insect and perhaps other hosts than man. Vast areas of the hinterland of South America and Africa are endemic centers of this so-called "jungle yellow fever."

H. C. PARMELEE
Editorial Director

Engineering and Mining Journal

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Manager

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Labor Note. A legal holiday on Sept. 22 last having been declared at Johannesburg on the occasion of the city's Golden Jubilee, the Transvaal Chamber's gold producers' committee recommended to the mines that they work on that day and that all natives so working be paid an additional 2s. 6d. and on the Sunday following be allowed an extra ration of 2 lb. of raw meat with kaffir beer at the discretion of the management.

Taxes paid by Consolidated Mining & Smelting Company of Canada were $2,000,000 in 1936, as compared with $1,131,124 in 1935 and $450,187 in 1934, according to the directors' annual report, which adds: "If such large sums were employed in production instead of diverted to the dead hand of government, national progress would be much accelerated." And the report also states, the end is not yet, as the budgets remain unbalanced.

Barilla, or tin concentrates, is the form in which the Patiño company, in Bolivia, ships its metal abroad to market. The concentration by gravity methods and flotation will be described in the June issue by D. C. Deringer, mill superintendent, and John Payne, Jr. This will be followed in the July issue by an article describing the company's hydro-electric power development, which suffices for the various needs of the enterprise.

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Volume 138 Number 5

MAY 1937

What Price Gold?

PROBABLY the most disturbing factor affecting business conditions since recovery began was the persistent rumor last month that the Administration proposed to reduce the price of gold below $35 per ounce. Despite the fact that authorities on both sides of the Atlantic immediately rejected the proposal as highly improbable, it was necessary for the President and the Treasury to make repeated denials before business was reassured. Nevertheless, the rumor had its world-wide effect, toppling prices for securities and commodities in fear of such a deflationary action.

Several obstacles stand in the way of immediately reducing the price below $35. The legislation of January, 1934, authorized revaluation of the dollar at not more than 60 per cent of its then statutory value. Acting under this authorization the President declared a revaluation of 59.06 per cent. He was quoted at the time as saying that this rate was selected in order to establish a "round figure" purchase price for gold. So without further legislation the President, under existing authority, could further reduce the price of gold only a few cents per ounce, quite insufficient to affect materially the production or flow of the metal. Without legislation, however, the Treasury could lower its *purchase price* for gold by several devices, but is not likely to do so unless it is convinced that the dollar should be revalued upward and that Congress later would be willing to ratify such action with legislation increasing the dollar's gold content.

International relations also demand consideration. The United States is party to a tripartite monetary agreement with England and France, and separate monetary action on our part is most improbable. That it would precipitate a world-wide economic crisis is a generally accepted opinion. The mere rumor of such an action had drastic speculative consequences. Finally, we have the presumptive indisposition of our own Treasury, already heavily in debt and with an unbalanced budget, to accept the tremendous paper loss that would be involved in marking down the value of gold.

Skeptics have questioned the ability of the United States to continue buying gold and "sterilizing" it. They have also asked what, eventually, we are to do with it. Undoubtedly the maldistribution of gold and its continual flow to the United States are matters of concern to our Government and others. Eventually some stabilizing action will be taken, but hardly without consultation and accord between the United States and Great Britain, at least, and possibly with other governments. When that will happen no one knows. Considering the intricate and time-consuming nature of such an international agreement, a materially lower price for gold and ability to dispose of the metal freely do not seem imminent at this stage of foreign exchange developments.

Mechanical Loading Surveyed

PROGRESS OF MECHANIZATION in mining metals and non-metallic minerals was greatly impeded during the darker years of the depression by conditions then prevailing. If the pressure toward mechanizing industrial operations be regarded as a war upon hand labor, then the struggle in the period referred to became a stalemate, thanks to opposing influences. The effort to keep men at work favored the retention of manual operation, if not an increase in its degree, whereas the need for lowering costs in the face of decreasing output put a premium upon anything that would promote efficiency, such as mechanization of underground loading. Perhaps the tremendous reduction in output outweighed all other influences affecting mechanical loading. At any rate, in the years specified the industry bought fewer and fewer scrapers and loading machines, the bottom in the case of the former being touched in 1931 and in the case of the latter two years earlier, as might be expected in view of the higher cost of the loading machine as compared with that of the simple scraper and hoist.

As conditions changed for the better, the falling sales curve righted itself, the year 1935 showed marked improvement, a movement that was greatly accelerated in 1936, when the sales referred to rose 84 per cent over those of 1935. This great increase must be interpreted with

caution. It must surely represent to an important extent some of the replacement made necessary by the failure to buy new equipment in the preceding lean years, when many an operator had only part of his equipment in service and used the rest to maintain this or replace it as it wore out. At the same time, better mechanical loaders are now available, improved design has helped toward wider use, and the great stride forward in this direction undoubtedly accounts for some part of the rise scored in 1936. The story is told in the results of an industrial survey recently made under Federal Government auspices, which forms the basis for the article by Messrs. Plein, Berquist, and Tryon elsewhere in this issue. The upward trend is most encouraging from every viewpoint.

Misleading Figures

ON APRIL 3 the Metals and Minerals Division of the Bureau of Foreign and Domestic Commerce issued a press release entitled "Sharp rise in copper export value — imports also higher." Uninformed newspapers picked up the item and interpreted it to mean that foreign metal was entering the domestic market, and that a large tonnage of domestic copper was going abroad. The inference was one of brisk international trade which, as a matter of fact, was misleading to those unable to analyze the figures.

The release was couched in terms of the *value* of copper exports and imports, and we may assume that the figures are correct. But, in language that has been made familiar by the Securities and Exchange Commission, the item omitted "material facts necessary to make the statements therein not misleading." No mention was made of price or tonnage. Most important, there was no reference to the excise tax of 4c per pound on imported copper, nor to the fact that so-called imports are in bond for smelting or refining, and for re-export without entering into the domestic market.

Consider the facts. Export invoicings of refined domestic copper in February amounted to 2,876 short tons. At the average February price of 13.828c per pound the value was only $795,386. This is a mere fraction of the Metals and Minerals Division's total estimate of $7,068,805, or even of $5,954,683 classified as "refined copper in ingots or bars." Those values obviously relate principally to the re-export of metal received in bond for smelting and refining.

It is equally misleading to talk about copper imports, regardless of their value, without reference to the excise tax. The business is of interest to smelters and refiners, but the metal does not enter into domestic commerce. It is not one of the "imports for consumption," in spite of the appearance of that item in the *Monthly Summary of Foreign Commerce.* Foreign copper, as ore or crude metal, is constantly flowing into and out of this country, but such imports and exports bear little relation to the domestic copper industry. The only true exports are of metal produced in the United States. There are no genuine imports in the face of the excise tax.

There is little value and some mischief in press releases like the one under discussion. Why not leave matters pertaining to metals and minerals to the Bureau of Mines, which is more conversant with the habits and customs of the industry? We were under the impression that the Metals and Minerals Division of the Bureau of Foreign and Domestic Commerce was to be abolished when the Bureau of Mines was transferred from Commerce to Interior. Apparently this was not done, with the result that there is needless and inaccurate duplication of work. The matter should receive attention in the plans for reorganization of the Government.

After the Wagner Act

HAVING been sustained by the Supreme Court, the National Labor Relations Act is now the law of the land. And as such its provisions for collective bargaining and other rights will be observed in labor disputes that burden or obstruct interstate commerce. But it is a law *for labor,* frankly designed and intended to promote the interests of organized labor.

No one will quarrel with laws to protect employees from exploitation and give them an adequate mechanism to secure fair treatment and a fair share in the wealth they help to produce. But the Government must be fair with *all* its citizens—employers as well as employees. In this respect the Wagner Act is a partisan law. In its definition of unfair labor practices its lays inequitable burdens on employers. They alone are curbed and restrained from exercising coercive measures which labor unions employ so freely.

In short, the balance of power has now swung so sharply in favor of organized labor that it cannot escape new responsibilities. Hence the strong movement for legislation that will define unfair practices for labor unions and impose upon them responsibilities in like kind and degree now imposed upon employers. A further desirable action would be to require of labor unions full publicity of their financial operations. Until many of these inequities are remedied the country will not have a labor policy that will promote industrial peace.

THE DENN SHAFT at Lowell, Arizona. This opening, with its present surface plant, will suffice for handling 1,000 tons daily down to 3,500 ft. The cages now used for hoisting ore will have to give way to skips

Shattuck Denn

Increases Production

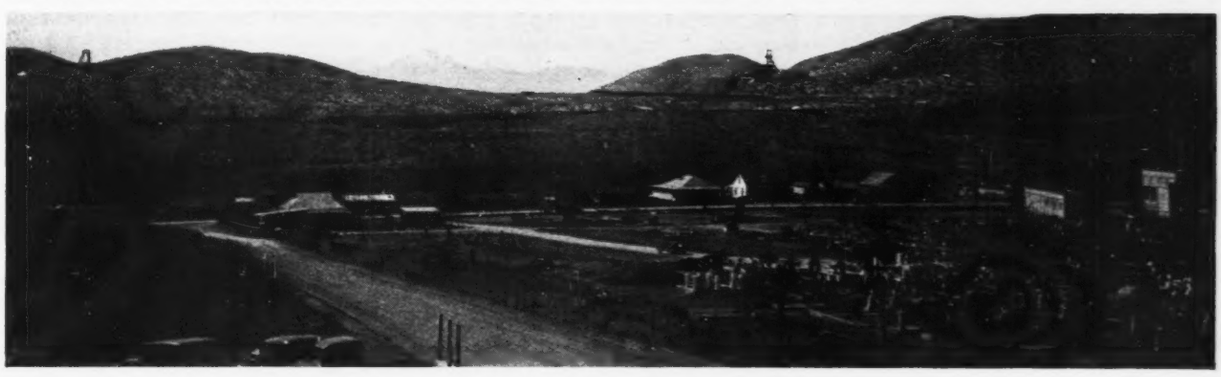
Its New Sulphide Orebody Is Being Developed Rapidly

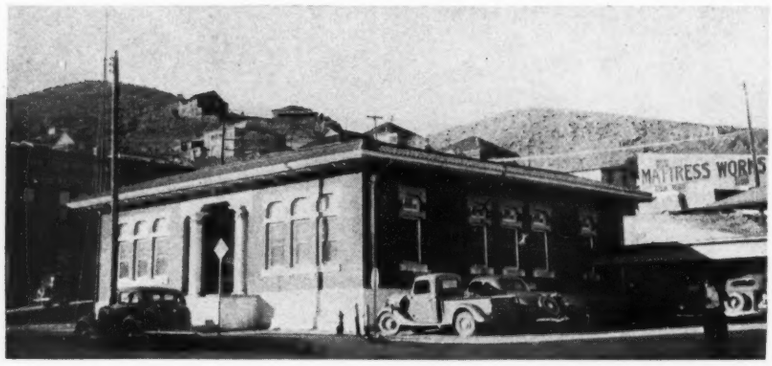
Worthen Bradley
President, Bradley Mining Company
San Francisco, Calif.

WHEN I visited the Denn mine of the Shattuck Denn Mining Corporation, at Lowell, Ariz., late in February, 1937, the sulphide orebody recently discovered was being rapidly developed on the 2,430 and 2,565 levels, with the intention of stepping up production gradually to 1,000 tons per day. Production at that time amounted to some 300 tons of 7 per cent copper ore daily, which was being shipped direct to the smelter at Douglas, Ariz. The Denn shaft and hoisting equipment are capable of handling 1,000 tons down to 3,500 ft., but a conversion to skips will be required in the near future. At present the ore is being hoisted in mine cars on double-deck cages. New smelting agreements will likewise be required with Phelps Dodge Corporation and American Smelting & Refining Company before the goal of 1,000 tons per day is reached, the present agreements calling for a much smaller tonnage, to be divided between them.

The new orebody lies with its top about 2,350 ft. below the surface. Its strike is roughly east and west, curving toward the south. It dips northeast, as far as can be judged by fault planes. It is developed on the 2,430 level to an extent of 600 ft. in length

LOOKING OVER PART OF LOWELL from the Denn shaft. Right and left are the Cole and Campbell shafts of Phelps Dodge Corporation





OFFICE of the Shattuck Denn Mining Corporation at Lowell. J. G. Flynn is resident general manager. L. C. Shattuck is president of the company

by 110 ft. in width, and diamond drilling has indicated a depth of 300 ft. The quantity of ore may possibly exceed 2,000,000 tons, averaging 7 to 10 per cent copper and $4 to $5 in gold and silver per ton. There are good widths assaying as high as 25 per cent copper, and, on the other hand, there are occasional horses of waste. Gold and silver values run as high as $10, and seem to bear no relation to copper content.

Present limits of the orebody are the Campbell fault on the east, and on the west a fault 150 ft. east of the Mexican Canyon fault. But a diamond-drill hole put down from the 2,200-ft. level showed high-grade ore at the 2,280-ft. horizon, east of the Campbell fault. Furthermore, on the 2,200-ft. level for a distance of several hundred feet to the east there is present lead-zinc mineralization which in the district is often characteristic of the upper fringes of a copper orebody. This seems to indicate further extension to the east, and may mean that the orebody when fully developed will be comparable to the great Campbell orebody of Phelps Dodge Corporation. (In that orebody, 3,000 ft. to the south, ore is found on both sides of the Campbell fault, and the outer boundaries of the orebody are marked by areas of lead-zinc mineralization, occasionally of sufficient intensity to be shipped as direct lead-zinc smelting ores.)

Preparations for stoping are proceeding actively on the 2,430 level. Mechanical loaders are used in drift and crosscut work. The mining system is a haulage drift down the middle of the orebody fed by inclined cut-and-fill stopes. Double-drum electric slushers are used in the stopes. Development is also in progress on the 2,565 level, the lowest level of the mine, where ore is rapidly being blocked out. Ore currently produced is obtained from the development and stope preparation described, plus regular production on the 2,310-ft. level from a lower-grade orebody at the western end of the mine along the Dividend fault. This sulphide orebody averages 5 to 7 per cent copper, and it is estimated that there are 500,000 tons remaining.

During the last few years the Denn shaft was concreted and sunk to 2,700 ft. at considerable trouble and cost. Prior to this, sinking had been abandoned due to excess water, but new shaft work in the district and a pumping arrangement with Phelps Dodge Corporation have helped unwater the mine. The collar of the Denn shaft is in limestone, and the shaft was sunk vertically, crossing the Dividend fault into barren schist before the 2,200-ft. level was reached. Below this level, crosscuts south from the shaft recross the fault into the ore-bearing silicified limestone. The headframe is steel, and winding is done by a 600-hp. double-drum electric hoist. Power is purchased both from Phelps Dodge Corporation and the local utility company.

L. C. Shattuck is president of the corporation with J. G. Flynn as resident general manager.

A Four-Pound Rock Drill Helps The Mine Surveyor

EQUIPMENT from the stone cutter's trade with which an inexperienced man can survey stations or control points in the roof of hard rock headings, has been adopted at the Idaho-Maryland mine, writes Rollin Farmin, Idaho-Maryland Mines Corporation, Grass Valley, Calif.

The drilling is done with a 1-in. pneumatic hand tool and carver's drill. One hundred feet of light, ¼-in. air hose with fittings for connecting it to the standard air-line outlets, together with a wrench and a few spare drills, completes the outfit, weighing 19 lb.

The carver's drill is a single, diamond-shaped bit which cuts rapidly but must be rotated by hand. The slower-cutting star-bit hand drill, commonly used for plugging concrete, can be adapted for use with the pneumatic hand tool by turning the shank down to ½-in. diameter in the lathe and tempering the shank to prevent burring in the chuck.

Holes drilled with this machine range from less than ¼-in. to ⅝-in. diameters. The hole for the survey station should be drilled 1 to 2 in. deep, then a precut length of hardwood dowling should be hammered into it, making a good anchor into which the spad is driven. A more permanent station can be placed by hammering a roll of sheet lead into the hole and driving a corrosion-proof brass spad into the lead.

A day or two before the start of a group of surveys, the helper is sent out to place survey stations in all of the drifts and crosscuts to be surveyed. He borrows the miner's air hose for a few minutes, connects the 100 ft. of miniature hose to it, and with the combined outfit can reach as much as 180 ft. behind the face of the heading to drill holes for the survey stations. An additional 100 ft. of the small hose can be used for long surveys where air outlets cannot be reached with a single length of hose.

HYDRAULIC MINING at the Reeves Ranch mine, in Siskiyou County, California. The hydraulic elevator pipe empties the gold-bearing gravel into this well-constructed sluice box

Sluice Boxes Must Pay

Careful design and construction of gold-recovery system essential to profitable hydraulic mining

William A. Newman
636 Vicente Ave., Berkeley, Calif.

SECOND in importance only to an adequate water supply and piping arrangement, in developing an hydraulic placer mine, is the installation of an efficient gold-saving sluice system. In opening a virgin placer deposit for the hydraulic method of operation, topographical conditions often render the construction of the near-perfect sluice system practically impossible. Where such circumstances exist—that is, lack of dump room or of right-of-way for a sufficiently long sluice—it becomes important that a sluice is designed and built that obtains the highest efficiency possible under these adverse conditions.

To design a sluice system accurately that meets as closely as possible all of the requirements of a particular placer mine, it is well first to have some understanding of the elements which control, directly and indirectly, the capacity of the sluice, and the methods by which transportation of gravel is effected. Some extensive experiments have been made on this subject by Gilbert,[1] which, to a certain degree, are applicable to the placer miner's problem.

Though actually there are no "average" placer gravels, most sluiceable gravels have a few features in common at least. That is, they are mixtures of fine sand, pebbles, boulders of various shapes and varying in weight from a few to hundreds of pounds, and, in many deposits, loam and clay, and all of these with different specific gravities. This is of interest inasmuch as where there exists a diversified mixture, not only is the otherwise total transportable load increased, but also a greater percentage of large material is movable for a given discharge of water than would be the case were all the material of one size.

Transportation of gravel by water in a sluice is accomplished by several methods simultaneously. The larger boulders will slide along the bottom unless, by virtue of their shape, they roll. The remainder of the gravel particles move by short leaps or jumps just above the bottom of the sluice. This is usually termed "saltation." Some of the lighter particles by this process of saltation are caused to leave the bed load, and are caught by the water currents and carried downstream in suspension. This, however, is a comparatively small portion of the whole, the major part being carried in the bed load. Several controllable conditions influence the bed load and hence the capacity.

Probably everyone connected with an hydraulic mine operation has

[1] Gilbert, Grove Karl: "The Transportation of Débris by Running Water." (U. S. Geological Survey Professional Paper No. 86).

noticed in the sluicing process the formation of waves on the water surface. These waves are of several types and are caused by the water surface adjusting itself to and conforming with the bed surface. When a sluice is carrying gravel but is underloaded, the bed load will mold itself into waves, or dunes, which travel downstream at a comparatively slow rate. This affects transportation and causes motion of their components by the current eroding particles from the upstream face of a dune and depositing these particles on the downstream face of the same dune.

As the load is gradually increased, these traveling dunes disappear, the water surface, becoming smooth, corresponding to the surface of the bed over which it is passing. At this point the efficiency of transportation (volume of gravel per unit of water passing a given point) as well as the gold-saving ability of the sluice is likely to lower because of the tendency of the load to pack from the weight of the superimposed water. This is particularly noticeable with gravel containing a large percentage of fine sands.

When the gravel load is further increased to the point where the water is carrying an overload, waves on the water surface and on the bed load appear again, individually similar in appearance to those first mentioned but differing in their direction of travel from those caused by an underload. These waves, or anti-dunes, as they are properly termed, travel in a direction opposite to that of the current and the gravel of which they are composed. They are formed by the erosion of particles from the lower, or downstream, face of any dune, and the deposition of these same eroded particles on the upper face of the next succeeding downstream dune.

There are several advantages in loading or crowding a sluice to this point where the formation of anti-dunes commences. The carrying capacity is increased by this additional mode of transportation (erosion and deposition), the sands are prevented from packing on the bottom, and the efficiency of gold recovery is increased by this constant agitation where otherwise a percentage of fine gold might be carried over a packed sand bottom and lost in the tailings.

The purpose of a sluice in an hydraulic mine is twofold: (1) That of transporting the alluvial gravels from the pit en route to their final resting place, and (2) of recovering the gold and black sands. In other words, the sluice is a combination of a conveyor system and a gravel-washing apparatus, and consequently should be built so as not to sacrifice the effectiveness of one function to that of the other. Up to the point when all the recoverable gold has lodged safely behind the riffles, the only substitute for length in a sluice is an increase in its efficiency. Where length is not practicably obtainable, adequate undercurrents are the best alternative.

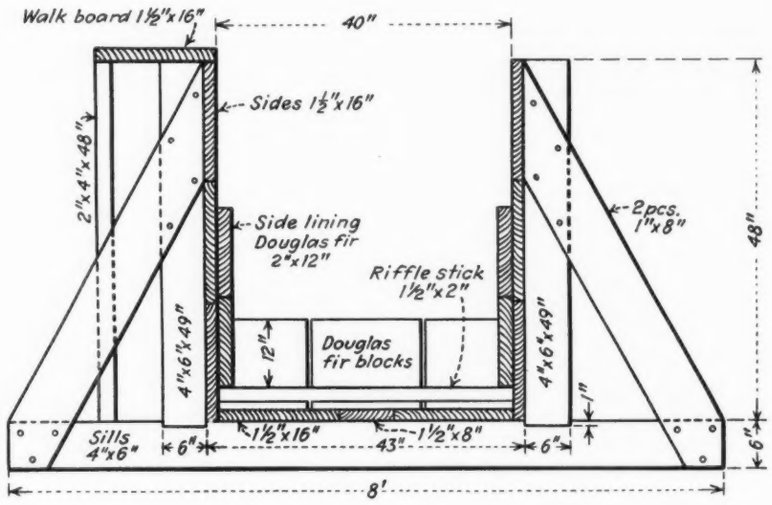
The length of a sluice system can be subjected to compromise, depending on the topography and the money available. The first factor in design to be considered is width. To arrive at the proper width, items to be considered are: maximum and minimum volumes of wash water available during the season, the grade of the sluice, and the size and percentage of boulders which can be disposed of by running them through the sluice.

In determining the width of the sluice, the accompanying table, based on average practice throughout the hydraulic mines of California and elsewhere, should prove helpful. The widths indicated will be found adequate for the volume of water used in the operation, assuming, of course, that suitable grade also is provided. In addition to the flow of wash water, these dimensions should handle adequately the volume of gravel, boulders, and sand this water will carry both by "bottom" transportation and in suspension.

Miner's Inches	Width, Inches
200 to 300	24
400	30
600	36
1,000	40
1,500 to 2,000	48
3,000	60

The figures in the second column of the table are the over-all inside widths of the boxes, the effective widths being lessened by the few inches taken up by the lining boards. These more or less empirical figures are based on grades of 5 to 7 in. per box of 12 ft. and assume average gravel with an average boulder condition prevailing, or where the duty of water should be in the vicinity of 3 cu. yd. per 24-hour miner's inch. With a sluice of adequate length these widths, with proper grade, should provide efficient gold recovery for such volumes of gravel.

Contrary to what might be expected, the recovery of fine gold is ofttimes improved by increasing within reasonable limits the grade of the sluice, especially where the gravel contains a large proportion of sands. When the grade is too light (say, 4 in. or less per 12-ft. box), the flaky fine gold has a tendency to float over the sand which this light grade has caused to pack on the sluice bottom. The heavier grade and correspondingly increased velocity of water will cause agitation of the sand particles, thus lessening the "packing" effect and permitting the gold particles to settle to the riffles by virtue of their specific gravity.



DETAILS in the construction of a sluice box, where blocks may be used as riffles. This sluice will satisfactorily handle 1,000 miner's inches (25 sec.-ft.) of water carrying gravel at a duty of 3 cu.yd. per 24-hour miner's inch

Sluices range in extent from a few boxes to lengths of a mile or more. The use of these exceedingly long sluices is usually more for the purpose of transporting and disposing of the washable gravels than for additional gold recovery. However, in many placer operations incidental recovery in the tail sluices at least pays for their maintenance. Usually a properly designed sluice of a few hundred feet will be found an adequate gold saver, especially if one or more drops between sections are provided and at least one undercurrent is incorporated in the system.

It is good practice to make occasional tests of the tailings during the operating season, and if colors are consistently found in the pannings, an effort should be made to increase

POLE RIFFLE sluices require little finished lumber and in many cases they are entirely satisfactory

the recovery. A possibility exists that the sluice system is not at fault but is improperly operated. That is, that the piper is allowing the sand to pack by running too large a volume of fine material without sufficient boulders and mud for proper mixture and transportation, or is rushing his gravel through too rapidly. However, assuming proper operation, it then becomes necessary to increase the length of the sluice or to add undercurrents, or do both, until the gold being lost becomes negligible. These additions can be made with a few boxes at a time until near-perfect recovery is attained.

At many hydraulic properties sawed lumber becomes an expensive item by the time transportation charges are paid. In an installation near timber and where a large quantity of lumber must be used in the construction of sluices, flumes, living quarters, and for other complementary purposes, the purchase of a so-called "vest-pocket" sawmill will soon pay for the expenditure. This mill, with an eight-hour capacity of 2,000 ft. B. M., will cost a few hundred dollars.

Plans of a box which I designed for a small placer mine in the Siskiyou of California are shown in the line cut. This sluice will satisfactorily handle 1,000 miner's inches (25 sec.-ft.) of water carrying gravel at a duty of 3 cu. yd. per 24-hour miner's inch. Because of the fineness of the gold and the presence of a large quantity of boulders which the sluice should carry off, it is set on the rather steep grade of 7 in. per 12-ft. box. Its total length is 400 ft., and it is provided with one undercurrent, 12 ft. in width and 8 ft. long, set on a grade of 1 in. to the foot. The undercurrent is placed near the end of the main sluice and carries all the material which passes through a transverse grizzly with ½-in. spacing between the bars. The sluice is 40 in. wide and the grizzly extends the full width of the sluice bottom for a distance of 18 in. Transverse bars are recommended as being superior to longitudinal bars, as they will bypass more fines without robbing the main sluice of too large a quantity of its water. The iron grizzly bars are ½ in. in width on their upper surface and taper slightly to their

WOODEN BLOCKS and flat boulders serve as riffles in these sluice boxes in Trinity County, California

underside. This taper helps prevent the grizzly from clogging with slightly oversize pebbles.

As shown in the line cut, the sides and bottoms of the boxes are constructed from 1½-in. partly seasoned yellow pine lumber, sawed as much as possible from the heart of the timber. Sap lumber is avoided because of its propensity for shrinking. A few sound knots per board are permitted as being unavoidable in the sides, but the bottom should be of selected clear. To make the bottoms fit perfectly, the three bottom boards are first placed on sawhorses, wedged side by side, marked and numbered so that their positions will be the same when placed in the box. Then they are ripsawed from end to end down through the two cracks formed by the three boards. In this way the longitudinal joints are made to fit perfectly and they will be absolutely watertight. No battens or splines are required with this construction.

As many small sawmills do not possess a planer, the bottoms of the boxes can be smoothed satisfactorily by running a light load of top gravel through the sluice for a couple of hours prior to the installation of the riffles. The frames, or yokes, formed by the sills and posts are built first and then set in place on grade with the help of a 12-ft. "straight-edge" and carpenter's level and square. These yokes are placed 3 ft. apart, center to center, and must be securely anchored in place by being weighted with boulders or by some other convenient method of keeping them in correct position.

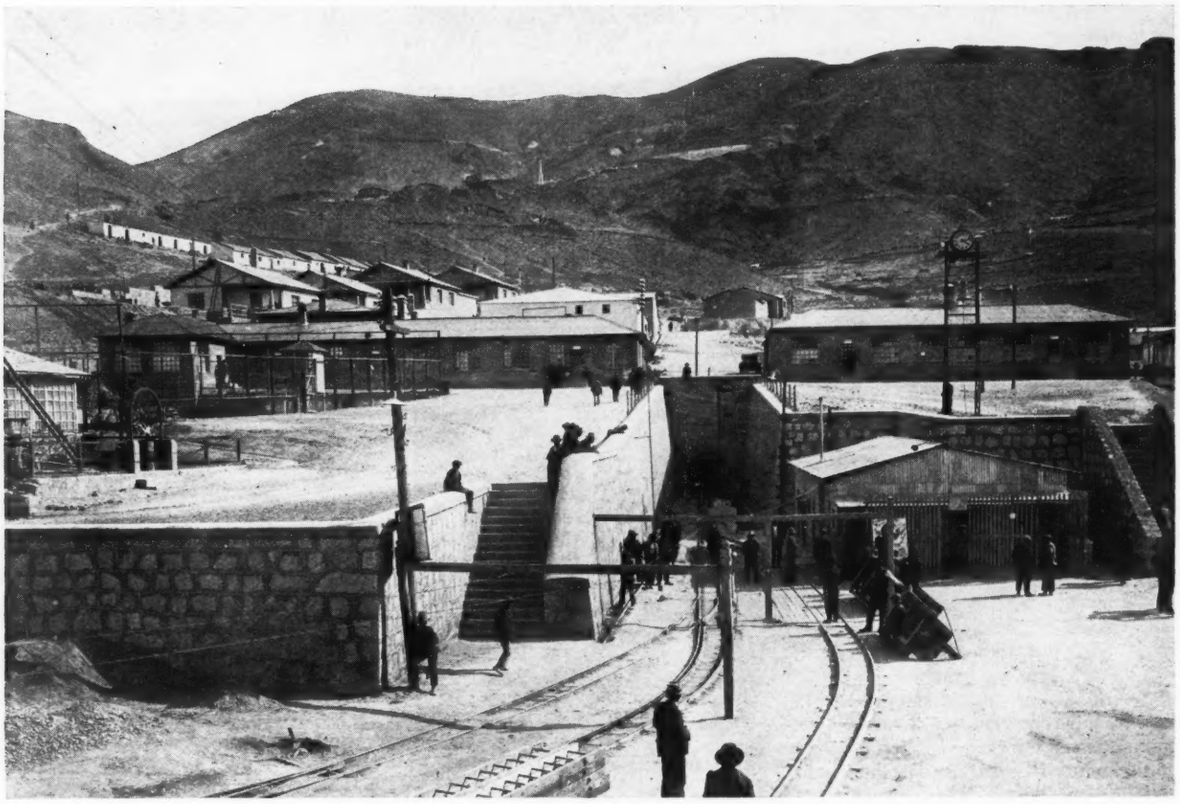
The riffles used in the suice illustrated were Douglas fir blocks 12 in. high and varying in size from 12x10 in. to 12x16 in., and hand-trimmed to fit. The purpose of this variation in size is to permit placing of the blocks in such a position as to prevent any continuous current between the blocks passing the length of the box. The blocks are held firmly in place by 1½x2-in. riffle sticks, as long as the width of the sluice, with 16d. nails driven both ways, so that one nail from each stick enters one block near the bottom. The riffle sticks are held down by 2x12-in. Douglas fir side-lining boards, nailed securely on the insides of the boxes for a height of at least two boards, starting about 3 in. from the bottom as shown in the illustration of the device which appears on page 230.

Iron T-rails, weighing from 30 to 45 lb., placed either transversely or longitudinally, also make extremely satisfactory riffles, and, though more expensive, will greatly outlast the wooden blocks. With certain gravels, particularly those of a cemented nature, the rails are considerably more efficient. The sluice with iron riffles will show a slightly increased capacity because of the lessening of friction on the "bottom load" and a consequent increase in velocity. The choice of riffles, however, usually depends on the amount of money available for the purpose.

After an initial run of a day or so, quicksilver is introduced into a few of the upper boxes, usually half a flask or more, the quantity being governed by the size of the sluice system. Additional quicksilver is placed in the boxes at regular intervals throughout the season. At some properties this is done once a month; at others, whenever an examination of the sluice fails to show a sufficient number of pools of clear quicksilver visible or the amalgam formed is found to be thick and sluggish.

PATIÑO

— Leading Producer of Tin



PORTAL of Siglo XX tunnel, which is driven south for 2500 meters from Siglo XX on the Llallagua side of Salvadora mountain. It is below most of the orebodies and serves for handling all ore and a large part of the men and supplies

II . . . Mining Practice at Llallagua—Crushing and Sorting the Ore

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Mill Superintendent *Chief Geologist*
Patiño Mines & Enterprises Consolidated, Inc.
Llallagua, Bolivia

AS IT IS TODAY, the Llallagua mine is a consolidation of two properties previously known as Llallagua and the Uncia, on Salvadora mountain. The orebody consists of a great number of veins and branches, in general parallel, striking northeast-southwest and usually dipping steeply either to the northwest or to the southeast. Distance between veins varies from a few meters to 200 or 300 meters. The area in which practically all of the ore is found is roughly 800 by 1,400 meters. The veins have been developed by levels driven at 30- to 35- meter vertical intervals, and intermediate levels as required, and are connected on different levels by various crosscuts. The levels are numbered vertically downward from the collar of Salvadora shaft, which is the zero level, its altitude being 4,522 meters.

The distinctive feature of the Llallagua mine is the enormous extent of the workings. The mine is divided into eleven sections, eight of which are now active, and each section is a complete unit. Fig. 6 shows the relation of the sections.

The San Jose-San Fermin vein is the richest single lode, but any one of many of the major veins would have individually produced sufficient to have made a large and important mine.

Tunnels—The Siglo XX tunnel, driven by the original Llallagua company, was begun in August, 1915, and completed in October, 1917. This is the principal operating tunnel through which all ore is extracted and a large part of the men and materials is handled. This crosscut tunnel was driven from the Llallagua side of the mountain, from the Siglo XX camp, at an elevation of 3,872 meters, or 650

meters below the Salvadora shaft collar. It runs almost due south, is 2,500 meters long, and is below most of the orebodies.

For a number of years before the combination of the two mines, the Uncia property of Mr. Patiño was worked through a long crosscut tunnel known as Socavon Patiño, driven into the hill from the camp of Socavon Patiño, on the Uncia side. This tunnel was driven northwest of and 383 meters below the collar of the Salvadora shaft. From its portal to Salvadora shaft is 1,970 meters.

The third important operating tunnel is Socavon Cancañiri, a crosscut tunnel entering the hill at 4,111 meters' elevation and 411 meters below the Salvadora collar, from the same side as Socavon Siglo XX. Before the latter was driven, this was the principal operating tunnel of the Llallagua company. It was driven south and is 800 meters long from its portal to the Besa shaft. A branch 360 meters long extends to the Reggis shaft. Because of its central location with respect to the vertical arrangement of the mine, the steel-sharpening shop and some of the compressors are located at its portal, and it serves as an entrance for main air lines and for transporting a large amount of supplies.

Vein Groups—For convenience, the veins may be divided into the following groups, starting from the northwest part of the mine:

Group I—Contacto, San Jose, San Fermin, San Pedro, Forastera, Forastera-Cabeceras, Paralela, Crucero, Blanca, Serrano, Vetilla, Cero, Falla, Nueva Cell, 700, Entre Fallas, Carnavalito A, Carnavalito B, and Encantada.

Group II—Salvadora, Inca, Transformador, Reggis, Rosas, Carvallo, Dos A, Uno A, Demasias, Bayona, and Reyes.

Group III—San Miguel, Esperanza I, Esperanza II, Nueva I, Nueva II, and 545.

Group IV—Animas, Bismarck, Victoria I, Victoria II, Victoria-Polvorin, Graciela, Polvorin, René, Plata, and Centenario.

Shafts—The mine has thirteen equipped shafts, ten of them now in use. They are listed in Table I. The Salvadora is perhaps the most important and the most centrally located. At present it extends from surface to the 411 level. Raising and timbering, however, are under way from the 650 to the 411 level. On completion of this work, the shaft will be the only one reaching from surface to the Siglo XX level, a distance of 650 meters, through almost the entire vertical extent of the mine.

A new hoist, now being installed in Salvadora shaft, is an Allis-Chalmers double-drum electric unit, built to operate with a rope pull of 14,000 lb. at 600 ft. per minute. The Salvadora is a double-compartment shaft with a third smaller compartment for pipes and manway. Each main compartment is 4 ft. 2½ in. by 6 ft. 2 in. The cages are to be double deck, made of Man-Ten steel, and the rope is to be of 1⅛-in. plough-steel cable having six strands, nineteen wires, and a hemp core.

As no ore is hoisted, the shafts are used entirely for handling men and supplies. With as many as 3,000 men underground, and more than 500 separate working places, the need for distributing steel, timber, and other supplies rapidly, and getting the miners to their working places without much delay, presents a problem.

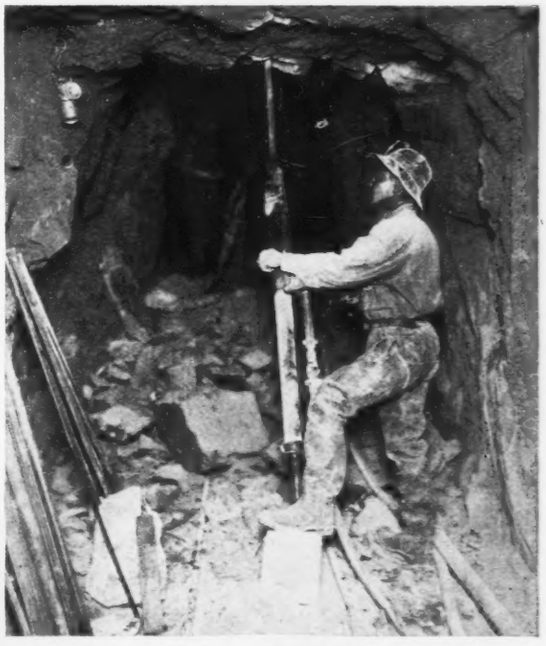
The mine is dry, and at present all water runs out the Siglo XX tunnel by gravity. Ventilation is good. Enough shafts and tunnels extend to surface to provide excellent circulation of fresh air. No artificial ventilation is used.

Ore Extraction—An intricate system of ore passes is provided, each of which leads to the Siglo XX level or to a main level, where the ore is retrammed to one of the principal ore passes. Ore is collected from the various working places in 1-ton, end-dump cars and hand-trammed on 20-lb. rails of 50-cm. gage to the main passes. In the Siglo XX tunnel as well as on certain retramming levels, haulage is done by trolley locomotives with 2-ton, side-dump cars on 40-lb. track of 60-cm. gage. For this work there are two 8-ton, twelve 4-ton, and two 2½-ton trolley locomotives. Switches and frogs are of the railroad type. Three 1½-ton storage-battery locomotives are also in use.

All ore is drawn from the main passes on the Siglo XX level, and hauled directly to the crushing and sorting plant, located between Siglo XX and Catavi, at a distance of 550 meters from Siglo XX portal.

Stoping—Prior to 1924 underhand stoping was the prevailing mining method, but since then shrinkage stoping has been adopted as standard. Recently some experimenting has been done with cut-and-fill stoping where the ground is weak, or where stope sorting might prove economical.

Disadvantages of shrinkage stoping at Llallagua are: (1) Much broken ore remains unavailable until the mining is completed and the ore can be drawn out. (2) In some stopes, after mining is finished and the ore is being drawn, the hanging wall caves and causes dilution. This also makes drawing of the broken ore difficult, and may require much chute blasting to remove the large boulders resulting. (3) In some areas it is difficult to fill the stopes after the ore has been removed, and if filling is not rigorously practiced, regions may be weakened which would have remained in good condition had the stopes been filled as soon as the ore was drawn.



PREPARATION WORK prior to shrinkage stoping. A block is mined as a unit. The first step is to take down the back of the drift to a height of 5 meters above the rail and for the length of the block and then to timber as the ground may require

UNDERGROUND TRANSPORT on the Siglo XX level. Eighteen trolley locomotives haul the ore in trains of 2-ton side-dump cars. Three storage-battery motors are also in service

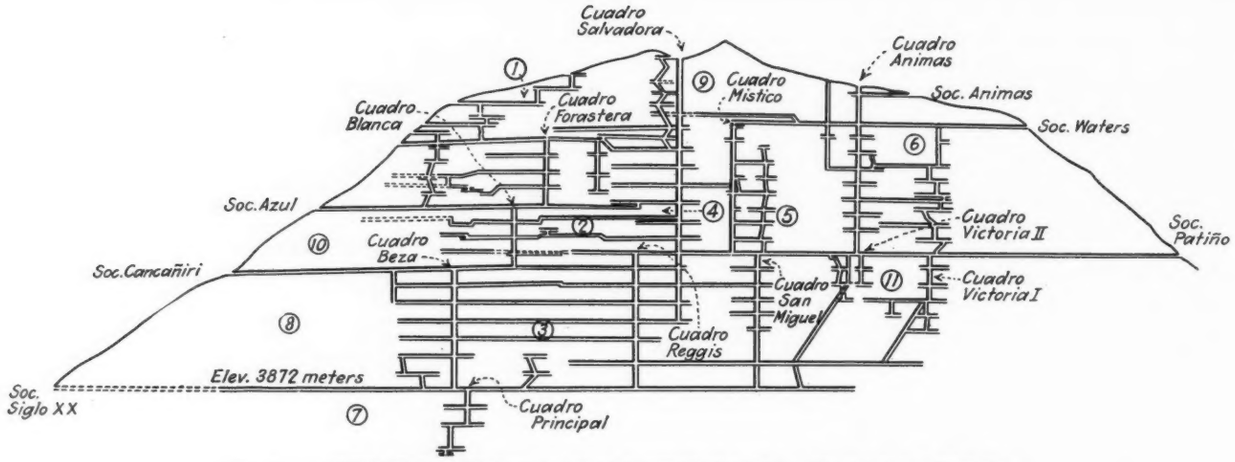


Fig. 6 . . . LLALLAGUA MINE in generalized longitudinal section. The numbers show the various mine sections as follows: 1, Azul. 2, Cancañiri. 3, Salvadora. 4, Laguna. 5, San Miguel. 6, Animas. 7, Siglo XX. 8, Ocho. 9, Nueve. 10, Diez. 11, Socavon Patiño.

Advantages of the shrinkage method are: (1) Low breakage costs. (2) Small timber consumption, in a country where timber costs are extremely high. (3) A large supply of broken ore is provided which may be regulated so that control of grade and quantity of extraction can be effective. (4) Because shrinkage stoping is widely used in Bolivia, and since 1924 at the Llallagua mine, it is understood by the Bolivian miner.

Reserve blocks are mined as a unit, which results in varied lengths of stopes, as the ore is irregular in both horizontal and vertical extent. The practical minimum length for an individual stope is 10 meters.

In the preparation of a block, the back of the drift is taken down to a height of 5 meters above the rail, and for the horizontal distance indicated by the reserve block. This broken ore is then mucked out and the opening is timbered. In ordinary ground, 8x8-in. stulls are used; but where the ground is heavy, 10x10-in. timber is sometimes required. If the ground is bad, posts and caps are used; whereas if the drift is of standard width and the rock is solid, stulls are secured in hitches cut in the walls. Wedges are not used for this purpose. All stulls are placed 90 cm. apart, and chutes 7 meters apart center to center. After the chutes are in, the stulls are lagged with 2x6-in. plank, which in turn is covered with large rocks to protect the timber when the first round is blasted in the stope.

In stoping, successive cuts are taken in the back and only enough ore (about 40 per cent of the total amount broken) is pulled to allow room for drilling the next cut. The rest of the ore remains in the stope until it is finished. All boulders are broken in the stope, so that the chutes will not hang up and the ore can be drawn without excessive chute blasting. Where mineralization is confined to one vein, stoping width can be reduced to 80 cm. Some stopes, however, must be widened to include stringer mineralization separating from the principal vein, so that the average stoping width is about 1.15 meters.

The stopes are carried with a manway at each end and in most cases a raise is driven to the next level, this serving as an additional entrance and facilitating the handling of material. Manways are carried with a dry-wall on the side adjacent to the broken ore, the wall being reinforced with 8x8-in. stulls. These are set in hitches in the walls.

AN UNDERGROUND CHAPEL in the Llallagua mine. The Bolivian miner is very religious, as this will indicate

Although many stopes offer no particular mining problem, frequently the standard practice cannot be applied, and the stope becomes an individual problem which must be solved in the most practical way. Stringers branching from the principal vein must be developed from the stope, and mined; otherwise these branch veins would be left and probably never recovered. This necessarily involves a large amount of development from the stopes, and complicates the mining problem. A stope may start from the drift on one vein and between levels the vein may be *en echelon*, or may split into several stringers. Such stoping problems offer constant opportunity for initiative and skill in mining to recover all possible ore from veins of such complex structure and irregular values.

Because of the short length of the average ore-reserve block, a great number of stopes are active. With ore being extracted from so many places, close supervision is needed to maintain grade control and prevent the mill heads from varying excessively. During 1935 the mine had an average of 121 active stopes. Table II shows the tonnages drawn, broken, and remaining in stopes during 1927 to 1935 inclusive. Table II-A shows the source of all ore extracted.

Variations of the standard method are necessary where the ore does not extend to the level below, and raises must be driven to the point where it bottoms, and development carried on above the main drift. Where this is necessary, raises are driven at regularly spaced intervals and these are connected and mining is begun above the sublevel thus developed.

In addition, brecciated areas occur which are very irregular in shape and have to be mined in accordance with the ore limits. These areas are developed by driving crosscuts at 7-meter centers. The backs of the crosscuts are then taken down and timbered as for a standard stope. The block is later undercut by removing the ground between each of the openings thus made. When the entire area has been undercut above the timber, the back is drilled in benches and the stope carried in successive steps to the next level, or until the ore becomes too poor to work. In mining wide stopes or irregular orebodies flat-hole drilling with Leyner drills has proved successful. The pillars left on the level by this procedure are later removed by stoping up from the level below, or by breaking them directly on the sill floor.

Careful supervision is necessary to prevent dilution by excessive breaking of waste in the stope walls. This is

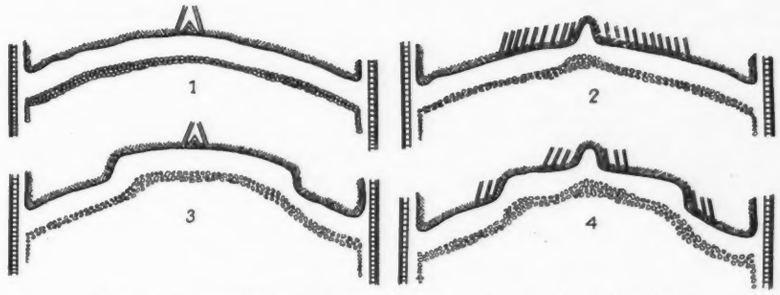


Fig. 7 . . . SUCCESSIVE STEPS in drilling the back in shrinkage stoping in the Llallagua mine

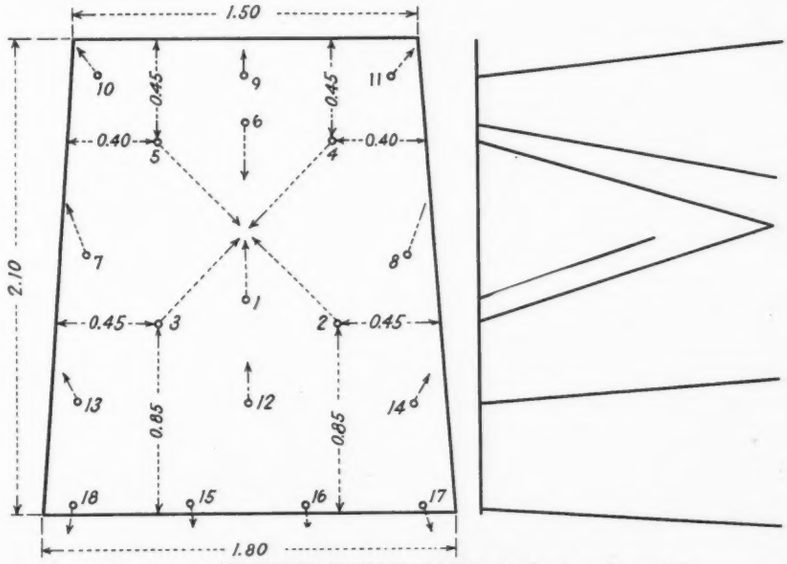


Fig. 8 . . . STANDARD DRILLING ROUND for hard rock used in drifting in Llallagua mine. It comprises eighteen holes with a pyramid cut

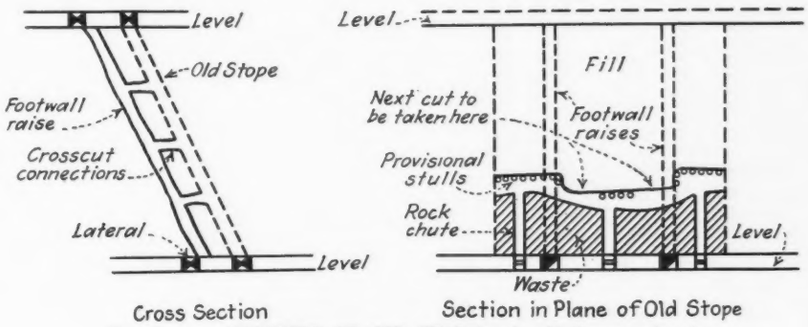


Fig. 9 . . . RE-MINING OF OLD FILLS in the Llallagua mine is conducted in the manner shown in these two sections

important in maintaining the grade at as high a level as possible. In general, the walls stand well and excessive sloughing is rare. No sorting, either of waste or high-grade ore, is done in the stopes.

Development—Maintenance of the development program is essential, so that available ore reserves will not lag behind stoping requirements. Table III shows the results of ore reserve calculations for the years 1925 to 1935 inclusive. During the past three years, the war between Bolivia and Paraguay has caused a serious labor shortage. This necessarily has worked a hardship, because sufficient men to carry on the extraction, break the required amount of ore in stopes, and at the same time keep up the development work have not been available.

The Llallagua mine has always found it necessary to carry on a large amount of development work because of the type of orebody, consisting of numerous small veins of irregular extent. Aside from the development, much operation work has to be done in connection with exploiting the irregular oreshoots, driving ore passes and shafts, gaining access to old areas that have been caved, and other necessary work aside from development or exploration, inasmuch as it cannot add to the ore reserves. Table IV shows the number of meters of development and other work driven over a ten-year period.

All development headings are driven according to standard specifications, drifts and crosscuts being 2.1x1.8 meters, raises 1.5x1.5 meters, and main haulage drifts 3.0x3.0 meters in cross-section.

Drills—For stoping, Ingersoll-Rand CC-11 stopers are standard. Most stopers were purchased several years ago. Lately, experimenting has been done looking toward the adoption of self-rotating stopers. This type may be adopted in the future if current tests prove that the Bolivian miner is capable of doing more with a faster-drilling or a heavier machine. Drilling speed, while the machine is actually working, has not proved so important at Llallagua, because the factor that retards over-all drilling time is not so much speed while the machine is drilling, as the excessive time spent in setting up, changing steel, and the like.

For all stopers, 1-in. quarter-octagon hollow steel is used. (Formerly, dry stopers were used, but these proved a constant danger to the miner on account of the dust, and have been replaced by wet machines. This change has greatly reduced the amount of silicosis among the workmen.)

For drifting I-R N-72 Leyner drills and DDR-13 mounted Jackhamers are used for drifting. The type of machine used is determined by the hardness of the rock. For drifters $1\frac{1}{8}$-in. round steel is used. A standard round for hard rock consists of 18 holes, using the pyramid cut. Fig. 8 is an example of this round. The type of round varies with conditions, ranging from 24 holes in extremely hard ground to 7 or 9 holes where the rock is soft. Table V shows the number of drilling machines used daily.

Although most drilling is done with machines, it has been found that hand drilling is economical where the rock is soft or in isolated places where an excessive amount of pipe would be required to reach the heading. The average advance per month in headings where hand steel is used varies from 3 to 15 meters, depending on the class of rock and the working conditions.

Compressors—Air is furnished to the working faces at 90-lb. pressure. In all, seven compressors are on the property. Table VI shows the capacities and locations of the various units.

Steel Sharpening—The drill-sharpening shop and drill-repair shop are at the Socavon Cancañiri portal. There are 13 I-R No. 50 sharpeners, 1 I-R No. 25 furnace, and 10 Muggli furnaces. Ogden Iron Works steel cars are used for transporting drill steel from the sharpening shop to the main points of distribution in the mine.

Dynamite—Three powder magazines are provided underground, so

Table I—Shafts, Llallagua Mine

Name	Levels Served	Vein Group Served	Class
Cuadro Besa	411 to 650	I	Single compartment, double-deck cages.
Cuadro Principal	650 to 720	I	Single compartment, double-deck cages. Not in use.
Cuadro Blanca	411 to 295	I	Single compartment, standard shaft.
Cuadro Forastera	295 to 160	I	Single compartment, standard shaft.
Cuadro Reggis	650 to 383	II	Double compartment, single-deck cage.
Cuadro Salvadora	411 to surface	II	Double compartment, single-deck cage. Being extended to level 650.
Cuadro San Miguel	383 to 650	III	Single compartment, standard shaft. Timbered only from level 383 to 470.
Cuadro Mistico	383 to 125	III	Under construction. To be single compartment, standard shaft.
Cuadro Victoria II	383 to 446	IV	Bucket with cable guides. Currently not in use.
Cuadro Victoria I	383 to 470	IV	Bucket with cable guides.
Cuadro Animas	383 to surface	IV	Single compartment, standard shaft.
Plano Inclinado	383 to 411	None	Inclined shaft used only for transporting material.
Polvorin	320 to 383	IV	Bucket with cable guides. Used for material only.

Table II—Tonnages Drawn, Broken, and Remaining in Stopes

(Dry Metric Tons)

Year	Tonnage Drawn From Stopes	Tonnage Broken in Stopes	Tonnage Remaining in Stopes
1927	225,220	337,545	180,193
1928	380,648	346,426	146,971
1929	435,825	439,133	154,122
1930	510,120	518,814	158,827
1931	483,100	487,192	186,835
1932	262,442	248,933	172,230
1933	132,925	121,543	160,348
1934	170,624	159,124	148,848
1935	278,188	261,848	132,508

Table II-A—Sources of Ore Extracted from the Llallagua Mine

Metric Tons

Year	Stopes	Development	Fills	Total
1930	510,120	82,102	161,864	754,086
1931	483,100	72,731	19,825	575,656
1932	262,442	45,593	27,528	335,563
1933	132,925	19,337	22,291	174,573
1934	170,624	26,323	15,057	212,004
1935	278,188	27,663	19,462	325,313

Table III—Mine Ore Reserves

Date	Dry Metric Tons	Grade, % Sn	Metric Tons Fine Tin
Dec. 31, 1925	1,061,000	4.74	50,289
Dec. 31, 1926	1,070,883	4.77	51,045
Dec. 31, 1927	1,231,091	4.74	58,346
Dec. 31, 1928	1,605,637	4.45	71,462
Dec. 31, 1929	1,964,864	4.20	82,606
Dec. 31, 1930	1,876,473	4.11	77,123
Dec. 31, 1931	2,005,708	3.87	77,559
Dec. 31, 1932	2,181,038	3.56	77,614
Dec. 31, 1933	2,126,066	3.57	75,815
Dec. 31, 1934	2,112,234	3.52	74,440
Dec. 31, 1935	1,930,992	3.49	67,304

Table IV—Amount of Development and Operation Work

Year	Drifts, Meters	Raises, Meters	Cross-cuts, Meters	Development Total Meters	Development Miles	Operation, Meters	Grand Total, Meters
1926	.....	.....	.....	9,583	5.95	.....	9,583
1927	8,858	3,610	2,939	15,407	9.57	.....	15,407
1928	13,572	4,309	2,129	20,010	12.43	2,305	22,315
1929	16,287	5,701	3,358	25,346	15.75	2,208	27,554
1930	14,358	3,780	3,383	21,521	13.37	4,098	25,619
1931	11,065	7,550	4,152	22,767	14.15	3,387	26,154
1932	7,020	5,679	3,749	16,448	10.22	2,133	18,581
1933	3,568	2,144	1,807	7,519	4.67	1,437	8,956
1934	4,890	1,677	1,590	8,157	5.07	1,442	9,599
1935	3,502	1,916	1,546	6,964	4.33	2,529	9,493

Table V—Drills Used Daily for Mine Operations

Year	Development	Preparation	Stoping	Various	Total
1927	90	30	152	21	293
1928	132	27	149	25	333
1929	164	36	169	31	400
1930	157	57	269	19	502
1931	124	52	270	17	463
1932	65	28	177	11	281
1933	50	7	83	8	148
1934	46	15	109	3	171
1935	51	24	174	16	265

Table VI—Compressors

Location	Number	Type	Sea-Level Capacity Cu. Ft. per Min.
Cancañiri (surface)	2	Ingersoll-Rand PRE 2 — 17½ and 30 x 21 in.	2,300
Cancañiri (surface)	2	Ingersoll-Rand PRE 2 — 21½ and 42 x 27 in.	5,300
Salvadora (mine)	2	Ingersoll-Rand PRE 2 — 14½ and 26 x 16 in.	2,050
Siglo XX (mine)	1	Ingersoll-Rand XCB 2 — 24 and 14 x 16 in.	1,420

distributed as to serve the various parts of the mine. These have a total capacity of 10,500 boxes, divided as follows: Siglo XX, 5,000; Cancañiri, 3,000; and Socavon Patiño, 2,500. The weight of each box is 42 kg. For most blasting 40 per cent gelatine powder is used, but both 60 and 50 per cent are required in some places.

These powder magazines are laid out so that they will have all possible safety advantages. Fresh air is maintained at a uniform temperature and is kept in constant circulation; the floors are kept clean and covered with moist gravel; and the men working in the magazines are not allowed to carry matches. Workmen drawing powder are required to deposit their lamps at a place especially provided and no one is allowed in the magazines except those actually working there. Electric lights are provided with protection against sparks and the light wires are incased in metal conduits.

For machine-drilled holes, 1⅛x8-in. cartridges are used; whereas for hand-drilled holes, ⅞-in. cartridges of 50 per cent strength are required. Clay tamping cartridges are made on contract on the surface, and the amount needed daily is taken in the mine for distribution to the contractors. Table VII shows the consumption of timber, dynamite, and steel.

Labor—Almost all work is on a contract basis. Standard wages are guaranteed, and any bonus is divided among the men participating. Prices are based on the hardness of the rock, there being three general classes: hard rock, medium rock, and soft rock; and the foreman in charge makes the price in accordance with the type of rock, keeping in mind any other pertinent features. Powder is furnished by the company and charged against the contract. Each miner does his own blasting. In narrow stopes, the pay is based on square meters broken, whereas if the width exceeds two meters, the contract is made on a cubic-meter basis. For development headings the price is based on the linear advance in meters.

Bolivian workmen do not adapt themselves readily to working with mechanical tools. Until June, 1936, the hours for working in the mine were extremely long, the miners remaining as much as ten hours underground. At that time the company voluntarily reduced the hours, so that now the workmen enter the mine on their own time but come out on company time, working an eight-hour shift. This results in all workmen being out of the mine by 3.30 p.m. The reduced working hours have greatly improved the workman's life, giving him more time which can be spent in the fresh air and affording additional time for recreation. For several years past the mine has worked

Table VII—Consumption of Timber, Dynamite, and Drill Steel per Dry Metric Ton Produced

Year	Total Consumpton of Timber, Bd. Ft.	Total Consumption of Dynamite, Lb.	Total Consumption of Drill Steel, Lb.	Production, Dry Metric Tons	Consumption per Dry Metric Ton		
					Timber	Dynamite	Steel
1930	3,148,026	1,149,170	550,208	754,086	4.17	1.52	0.73
1931	1,964,696	1,065,561	571,609	575,656	3.41	1.85	0.99
1932	1,048,097	630,763	242,276	335,563	3.12	1.88	0.72
1933	327,670	306,072	64,761	174,573	1.88	1.75	0.37
1934	336,254	355,017	273,692	212,024	1.59	1.67	1.29
1935	699,348	474,005	191,102	325,313	2.15	1.46	0.59

on day shift only. Table VIII shows the average number of men employed.

On account of the labor shortage, women are employed underground. The first women workers entered the mine in May, 1935, and by September, 1936, there were about 200.

Each section of the mine has its underground time office, where the time card for each workman is changed as he goes on and comes off shift. Final liquidation of contracts is made monthly, but the men are paid every two weeks, receiving their full pay and bonus one time, and only one *boliviano* per shift the other. Deductions for accounts in the company stores and other reasons are made at the time of final liquidation.

Waste Filling—In former years waste-filling of finished stopes was not consistently practiced. This has resulted in weakening certain areas through leaving too much ground open. Recently, a filling program has been initiated which is proving of great value in keeping actively stoped areas from becoming unnecessarily heavy. The waste is brought from surface through passes, and thence distributed where needed. To date, all waste has been taken from old dumps, but this policy is to be discontinued, because if sorting is practiced, many of these dumps contain sufficient values to be treated. Plans now call for surface glory holes, one for each vein group, to provide a constant supply of clean waste available for filling stopes as they are finished.

Old Dumps—The assets of the company include many dumps that are on the property. Much of the material in these dumps was mined during former years, when only high-grade ore was shipped to the mill. Consequently, under present conditions, it is of economic value. The advantage of this material is that it is already mined and is amenable to concentration, both factors being important to the cost of working it.

Table VIII—Average Number of Men Working Underground and on Surface

Year	Interior of Mine	Surface Work	Total
1930	2,759	1,451	4,210
1931	1,911	770	2,681
1932	1,524	537	2,061
1933	871	358	1,229
1934	989	382	1,371
1935	1,378	539	1,917

Fills—The mine has numerous old fills. Many of them carry surprisingly good values and can be re-mined at a profit. To date, only hand sorting has been practiced, but the plan is to re-mine them systematically where the values will permit. The richest of the known fills are on the San Jose-San Fermin vein. These are to be re-mined as follows: First, a lateral is driven on the footwall. At 15-meter intervals a crosscut is driven to the old drift, which was on the vein. The pillar between lateral and drift is 4 to 6 meters of solid ground. From each crosscut a raise is driven parallel to the old stope, and with a 3-meter pillar between raise and fill. This raise is continued to the next level above, connections being made with the old stope every 8 meters, or more often if required. When the raises are connected, mining is begun.

The fill above the old drift is taken down as in preparing for stoping. As soon as a small amount of the fill is removed, provisional stulls are placed to prevent further running of the loose rock. Thus small "bites" are taken out along the back until a distance of 50 meters has been prepared. When this is completed, chutes are placed at 10-meter intervals, with a manway through the old fill in the center of the portion to be re-mined. These chutes are built of rock and are large enough to be used as an exit for men if necessary.

Re-mining is carried on as a cut-and-fill stope, with waste sorted in the stope. When additional waste is required, a crosscut is driven in the wall. This is not often necessary, as the ore is high in grade and easy to sort. The important point is to take the fill from the back in small quantities, and keep following up with provisional lagging so that the loose rock will not run. The stulls thus used are removed when the next cut is taken, and are re-used. Fig. 9 shows the procedure in re-mining old fills.

Table IX is a tabulation of general mine costs.

Crushing-Sorting and Storage Plant—All ore is hauled directly from the mine in 2-ton cars to the crushing and sorting plant, where it is dumped into a 650-ton concrete bin, from which it is discharged by a chute feeder to a 30-in. conveyor belt. This conveyor transports the ore to two grizzlies with a bar spacing of 3 in. The grizzly oversize then passes through two No. 10, 13-in. McCully gyratory crushers. This crushed product and the undersize from the grizzlies join, and are carried by a 24-in. conveyor to two 48-in. by 8-ft. punched-plate trommels with 1½-in. by 3-in. slots. Trommel oversize is washed thoroughly on two Leahy vibrating screens and passes on a 24-in. conveyor to a 900-ton sorting ore bin. Trommel undersize passes

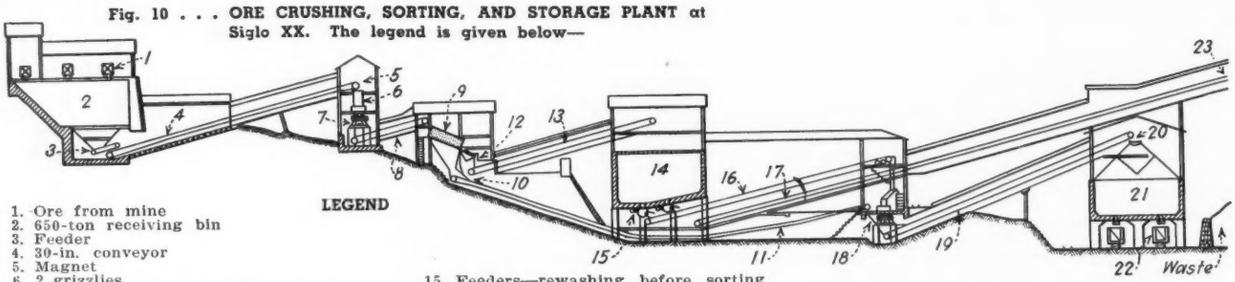
Table IX—Total Cost in Bolivianos per Dry Metric Ton Delivered to Mill

Year	Development	Stoping	Pillars	Handling	Haulage	Sorting	Dumps	General	Total
1927	Data not available								27.13
1928	Data not available								21.65
1929	4.66	4.49	1.18	2.45	0.96	1.74	0.26	6.97	20.97
1930	4.07	6.50	0.40	2.78	0.73	1.22	0.07	6.48	21.03
1931	3.80	7.30	0.26	2.52	0.76	0.58	....	4.94	18.66
1932	4.28	6.26	0.04	1.77	0.58	0.47	....	7.73	21.13
1933	4.09	5.34	....	1.97	0.63	0.45	....	[1]0.52	23.00
1934	4.02	7.41	....	2.03	0.66	0.60	....	8.46	23.19
1935	2.20	7.57	....	2.00	0.76	0.69	....	7.53	20.76

Table X—Operating Data—Siglo XX Sorting Plant

Year	Dry Metric Tons						
	Total Ore Extracted From Mine	Grade Ore Extracted From Mine	Waste Sorted	% Waste Sorted	Grade Waste Sorted	Ore Shipped to Mill	Mill Heads, Catavi
1930	695,994	3.32	161,513	23.2	0.69	564,561	3.96
1931	546,492	3.48	113,422	20.8	0.70	432,342	4.20
1932	308,993	3.26	61,793	20.0	0.91	248,485	3.85
1933	162,236	3.47	20,021	12.3	0.60	141,141	3.84
1934	203,510	3.37	28,962	14.2	0.50	179,612	3.86
1935	318,571	3.33	41,674	13.1	0.48	275,996	3.76

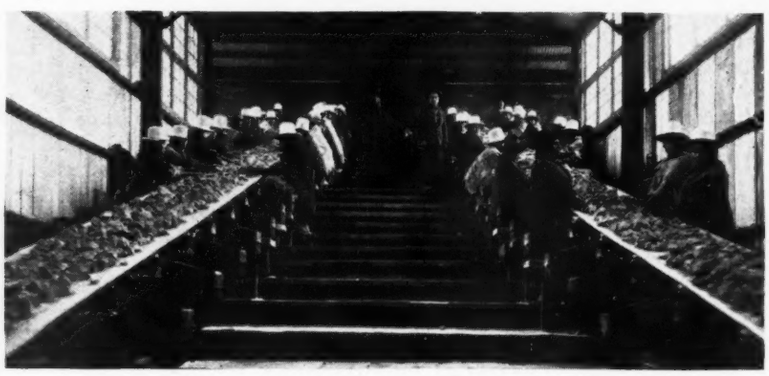
Fig. 10 . . . ORE CRUSHING, SORTING, AND STORAGE PLANT at Siglo XX. The legend is given below—



LEGEND

1. Ore from mine
2. 650-ton receiving bin
3. Feeder
4. 30-in. conveyor
5. Magnet
6. 2 grizzlies
7. 2 No. 10 Superior McCully crushers
8. 24-in. conveyor
9. 2 trommels
10. Undersize from trommel passes to 16-in. conveyor
11. 16-in. conveyor—undersize feeds directly to milling ore conveyor
12. Oversize from trommel washed on Leahy screen; slimes to settling tanks
13. 20-in. conveyor
14. 900-ton sorting ore bin
15. Feeders—rewashing before sorting
16. 2 30-in. sorting conveyors
17. 16-in. conveyor
18. 2 No. 6 Traylor Bulldog finishing crushers
19. 2-in. milling-ore conveyor
20. Shuttle conveyor
21. 3,200-ton milling-ore bin
22. 35-ton railroad cars
23. Waste passes over Weightometer, then to waste dump on movable spreader conveyor

CRUSHING AND SORTING PLANT at Siglo XX. Here women are employed on the picking belt over which the ore is passed after being crushed and screened. A 3200-ton concrete bin serves for storage prior to concentration



ON THE PICKING BELT in the ore-sorting plant at Siglo XX. In all, 104 women are employed

on a 16-in. conveyor to the 20-in. milling ore conveyor, bypassing the finishing crushers en route.

Slimes and fine sand from the vibrating screens go to a settling tank, are dried, and sent to the mill at irregular intervals. The ore is discharged from the sorting ore bin by four 36-in. apron feeders, each pair emptying onto a 30-in. picking belt, which travels 30 ft. per minute. The ore is re-washed as it is discharged onto the picking belt. Space provides for 104 women to do the sorting. All waste, which constitutes 12 to 20 per cent of the ore mined, is carried by a 16-in. conveyor to the waste dump. Small, movable, auxiliary belts are used on the waste dump to facilitate a more uniform distribution.

Ore remaining on the picking belt passes to two No. 6 Traylor gyratory finishing crushers, where it is crushed to minus 1½ in. All crushers have magnetic protection. The product from these crushers then joins the undersize from the two 48-in. trommels and passes on the 20-in. milling ore conveyor to an 18-in. shuttle conveyor, by which it is possible to distribute the ore uniformly throughout the 3,200-ton concrete milling-ore storage bin. The ore is then discharged into 30-ton railroad cars for transportation to the mill in Catavi.

Table X is a tabulation of the performance of the crushing and sorting plant.

Mechanical Department. — The mechanical department of the mine is under the mine master mechanic, who is also in charge of all construction work. Currently, September, 1936, this department consists of 90 men in the machine and blacksmith shops, 78 men in the carpenter shop, 38 masons and helpers, 4 pumpmen, and about 220 men in various bull gangs doing such work as building roads, making excavations, and other complementary operations.

The Siglo XX machine shop is equipped to do all routine repair work for the mine, and in addition much special work is done because of the frequent delays and uncertainty in arrival of replacements and spare parts from abroad. This shop is equipped with a 26-in. lathe, two 18-in. lathes, an 18-in. drill press, two small drill presses, a saw sharpener, a 4-ft. radial drill, a portable gib crane, a saw for metal, a bolt cutter, a pipe machine, a 24-in. shaper, a 12-in. shaper, a cylinder boring bar, a 12-in. heavy-duty electric grinder, a 6-in. electric grinder, a punch and shear, and an electric welding outfit.

The main blacksmith shop is at Siglo XX, but there are also small repair and blacksmith shops at the sorting plant, at Canceñiri, and at Socavon Patiño.

The carpenter shop makes necessary repairs on buildings, makes furniture, and does construction work. This shop is equipped with a scroll saw, a sewing machine, a universal woodworking machine, a surfacer, and a 10-in. pattern lathe.

Timber used in the mine is Oregon pine and Douglas fir, some of which is imported in large sizes, and is cut into required lengths for use underground by a No. 361 Fay and Egan band saw, which is located at Canceñiri. This saw does all ripping of large timber, but at both Canceñiri and Siglo XX there are the following saws to frame lumber and cut firewood for domestic use: a crosscut circular saw, a circular ripsaw, and a disk saw.

(*To be continued*)

When Specifying Alloys

For Equipment

One should know something of the analyses and qualities of those available

CHOICE of the correct alloy iron or alloy steel in drawing up specifications for mining and milling equipment will have a decided bearing upon the length of service to be rendered subsequently by the equipment, as is well known. The number of commercial alloys available today is rather confusing, however, and the correct choice can be made only with a knowledge of the compositions and characteristics necessary to meet specific operating conditions. Where resistance to oxidation, heat and corrosion, or impact and abrasion is wanted, or where strength, toughness, and ductility are necessary, the information in accompanying tables may be helpful.

Mine waters vary so in analysis that it is difficult to write the exact chemical reaction that would take place with steel or to predict the rate at which it would progress. A preliminary test of the water and its action on a corrosion-resistant alloy is therefore desirable before the latter is recommended. Mine water may be alkaline, in which circumstance the corrosion problem is frequently solved by the use of mildly corrosion-resistant steels. If it carries halogen salts, such as chlorides or fluorides, a more highly alloyed chromium-nickel-molybdenum steel may be necessary.

When iron is exposed to the action of dissolved copper ions, it is dissolved and metallic copper is precipitated. This is useful where copper is being recovered from mine water by means of scrap iron, but is destructive to iron or steel piping and equipment. Use of chromium alloy or stainless steel for the parts exposed to this type of corrosion will usually greatly prolong the life of the equipment.

Whether an 18-8 chromium-nickel stainless steel should be used for resisting acid mine water, or whether a more highly alloyed steel or a straight chromium steel would be preferable, should be determined by actual test. On the exact analysis of the mine water would depend the recommendations.

In many instances the use of stainless steel has been a vital factor in prolonging the life of equipment. Wire ropes and cables of stainless steel have been found to last 3½ years in hot atmospheres of various humidities, whereas ordinary steel lasted only 9½ to 29 months. Various metals, including steel, cast iron, brass, bronze, lead, and combinations of these metals, have failed to give satisfaction when used in the manufacture of mine pumps, but chromium alloys have been used successfully. As examples may be cited a 28 per cent chromium steel used for pumps handling high-acid water and silt with no apparent deterioration after a year's service, whereas bronze pumps failed in three months. The chromium steels, when used in valve stems, showed negligible wear after 2,200 hours, whereas the lead-bronze valve stems were good for only about 150 hours. Depending upon the type of mine water to be handled, different types of chromium steels have been used in pump columns.

Use of stainless steel in flotation equipment may be a factor in obtaining good results. Evidence indicates that iron dissolved by acid solution may affect results where sharp separations are required. Furthermore, as the concentration of some flotation reagents is only a few parts per million, any lowering of it through reaction with metal from iron or steel equipment might affect recoveries. Stainless steels, in particular the 18-8 chromium-nickel type, seem to be little affected by the usual flotation reagents.

For many applications such highly alloyed steels are unnecessary. Fans and ventilating equipment, piping, pumps, tubing, and valves have given good service when made of 4 to 6 per cent chromium steel. In high-temperature applications requiring freedom from growth, cast irons containing only 1 per cent chromium have shown marked superiority to plain cast iron.

For resistance to corrosive attacks at high temperatures, however, especially when sulphur gases are involved, the 26 to 28 per cent chromium alloys have been most successful. Such metals are being used most successfully for rabble arms in zinc roasting plants. The low-carbon alloys give better service and may be used for temperatures approaching 1,000 deg. C. The high-nickel alloys should not be used for this purpose in gases containing more than 2.5 per cent sulphur.

Table I shows typical compositions and applications of ferrous alloys used in mining and milling for their resistance to oxidation, heat, and corrosion. As almost all of them contain chromium, they are arranged in ascending order of chromium content.

Resistance to Impact and Abrasion.—The service life of many types of mining and milling equipment can be greatly extended by using alloys that will increase their hardness and toughness. Chromium and manganese are the principal elements used in making hard and abrasion-resistant alloys, and combinations of these with nickel, molybdenum, or vanadium to increase the toughness. For instance, these metals are important in gears that are subject to heavy shock. Tungsten is also used to increase hardness, but mostly in tools, such as mining chisels. Care must be taken in selecting hard and abrasion-resistant materials if they will need to be machined. A steel containing 13.5 per cent silicon and 1.0 per cent carbon, for instance, is resistant both to abrasion and to many mine waters, but it cannot be machined. Cast irons containing 1 per cent chromium and also low-carbon steels of very high chromium content can be made quite machinable. The chromium-nickel austenitic steels are readily machinable, and most of them have good abrasion resistance.

Cast irons containing 1.5 per cent chromium and 4.5 per cent nickel have good resistance to the erosive action of sand and sludge. Moreover, such castings, when ground, have greater ability than standard cast iron to withstand pitting and corrosion. They have been used in crushing ores, and have lasted three times as long as ordinary cast iron.

High-carbon vanadium steels are suitable for skip wheels, crusher parts, battery tappets, and rock drills, because they can be made hard without becoming brittle.

Worm wheels for Dorr classifiers have given good results when made of chromium-nickel steel. The bull gears and the gears that pull the bucket lines of large gold dredges are made of nickel-chromium steel, but the buckets are of cast manganese steel. Sometimes manganese steel is also used for gears and pinions.

Manganese steel has been used extensively in power shovels, because it has marked tendency for self-hardening of the working faces in service. In addition, these steels are tough and have high tensile strength and shock resistance. They are used for racks and pinions and for dipper teeth. Much ore-dressing equipment is made of manganese steel. Pan conveyors

Table I—Ferrous Alloys Used for Resistance to Oxidation, Heat, and Corrosion

Composition (a)		
% Chromium	% Other Elements	Typical Applications
.....	13.5 Si; 1.0 C	Castings resistant to mine water (not machinable)
1.0-1.25	.....	Cast-iron heat-resistant furnace parts, such as arch bars, door frames, door jambs, door liners, grate bars
1.50	4.50 Ni	Cast-iron pump bodies (abrasion resistant)
4.0-6.0	.....	Fans and ventilating equipment, piping, pumps, tubing, valves
12.0-14.0	0.12 C (heated-treated)	Coal screens, mine pumps, valve stems
12.0-16.0	.....	Perforated shaker plates
15.0	.....	Cast-iron pyrometer protectors
17.0-19.0	8.0-25.0 Ni; (2.5 Si optional for valves)	Diesel engine valves, wire ropes and cables, tanks for mixing and storing flotation reagents
24.0-28.0	10.0-12.0 Ni	Valve stems and disks resistant to acid copper-bearing sulphate waters
25.0	.....	Baffles, bolts and nuts, chutes, conveyor flights, jig and shaker screens, shovels
26.0-28.0	0.5-1.0 Si	Mining machinery, piping, pumps, rabble arms, screens, valves

(a) The amounts of manganese, silicon, etc., in these metals are nominal when not indicated.

Table II—Ferrous Alloys Used for Resistance to Impact and Abrasion

Composition (a)		
% Chromium	% Other Elements	Typical Applications
.....	0.18-0.25 V. (0.20-0.30 Mo opt.)	Mine drills
.....	3.25-3.75 Ni; 0.50-0.80 Mn	Gears (for heavy shocks)
.....	12.0 Mn	Dipper teeth, gyratory crusher parts, hammer and swing type crushers, jaw crushers, pan conveyors
0.15-0.25	.....	Pistons and piston rods
0.25	0.50 Mo; 0.5 to 0.70 Mn; 3.0-3.20 C	Cast-iron ball-mill liners
0.40-0.60	0.22-0.28	Knocker bars
0.40-0.60	1.10-1.40 Mn; 0.70-0.80 Si	Shovel and buckets
0.45-0.75	1.0-1.50 Ni	Gears
0.50	0.75 Ni	Cast-iron locomotive piston rings (machinable)
0.50-0.80	0.15-0.25 Mo	Mine car-wheel axles
0.55-0.75	.....	Cylinders for pneumatic hammers
0.60-1.0	1.60-2.0 Ni; 0.30-0.35 Mo	Crane wheels, dredging parts, gears, grizzly bars, pinions, pulverizing hammers, sprockets
0.75-1.25	0.30-0.40 Mo; 0.20-1.0 C	Crusher plates, dipper teeth, liners for grinders and pulverizers
0.80-1.10	0.70-1.0 Mn	Cylinders for pneumatic hammers, mine-car wheel axles
0.90-1.25	1.50-2.0 Ni	Driving chains, gears
1.35-1.45	2.30-3.0 W; 0.15-0.20 V	Chisels
1.40-2.25	4.25-4.75 Ni; 2.70-3.60 C	Cast-iron ball-mill liners, crusher jaws and rolls, grinding balls
1.50	0.40-0.60 Mo; 0.4-0.5 C	Dipper teeth
1.50	4.50 Ni; 2.0-3.0 C	Cast-iron crusher jaws, grinding-mill parts, pump bodies for sand and sludge
1.90-2.50	0.67-1.77 C	Grinding rolls
2.20-2.25	0.30-0.40 Mo; 0.90-1.0 C	Muller rings
3.0	.....	Grinding balls, railroad rails, Frogs and switch points, parts of crushing and grinding machinery.
25.0	1.0-2.0 Ni; 1.0-2.0 C	Jaw crushers

(a) The amounts of manganese, silicon, etc., in these metals are nominal when not indicated.

Table III—Ferrous Alloys Used for Strength, Toughness, and Ductility

Composition (a)		
% Chromium	% Other Elements	Typical Applications
.....	1.25-1.70 Mn; 0.20 Cu	Skip hoists
0.40-0.60	1.1-1.40 Mn 0.7-0. Si; (V opt.)	Buckets, piping, shovels, tubing
0.45-0.75	1.0-1.50 Ni	Shafts for steam shovels, rock crushers, and other heavy-duty equipment
0.50	0.20 Mo	Armature shafts
0.50-1.5	0.50-1.0 Si; 0.30-0.50 Cu	Mine cars, air-brake reservoirs
0.60-0.95	0.20-0.30 Ni	Buckets, piping, shovels, tubing
0.80-1.10	0.15-0.25 Mo	studs, and pins; clutch gearing other heavy-duty equipment
0.80-1.10	0.18 V	Same as above; also highly stressed bolts, studs and pins; clutch gearing

(a) The amounts of manganese, silicon, etc., in these metals are nominal when not indicated.

on a roller track are made of 10 to 14 per cent manganese steel, and individual manganese-steel screens have handled over one million tons of sand and gravel without replacement. Manganese steel liners of rod mills give good service, and when worn out can be cut up and used for chute lining. The rods themselves are of 1 per cent manganese, 1 per cent carbon steel. For many grinding and crushing applications, however, the chromium or chromium-nickel steels will give longer service. Chromium steels are also being rapidly and successfully substituted for other parts subject to high acid content along with such abrasive mixtures as sand and water. Jig parts, stationary dewatering screens in front of overflow-type jigs, chute plates, piping, and lining pump are typical examples. The choice of metal, however, depends much upon local conditions.

Table II gives typical compositions and applications of ferrous alloys used in mining and milling on account of their resistance to impact and abrasion. The compositions of these are also arranged in accordance with the increasing chromium content.

High-Tensile Alloys—Though resistance to corrosion and to abrasion are the prime requisites in certain equipment, strength, toughness, and ductility are most important in other equipment if the latter is to give efficient service with economy. Other things being equal, parts made of strong structural and engineering metals do not need to be so heavy as those made of weak metals.

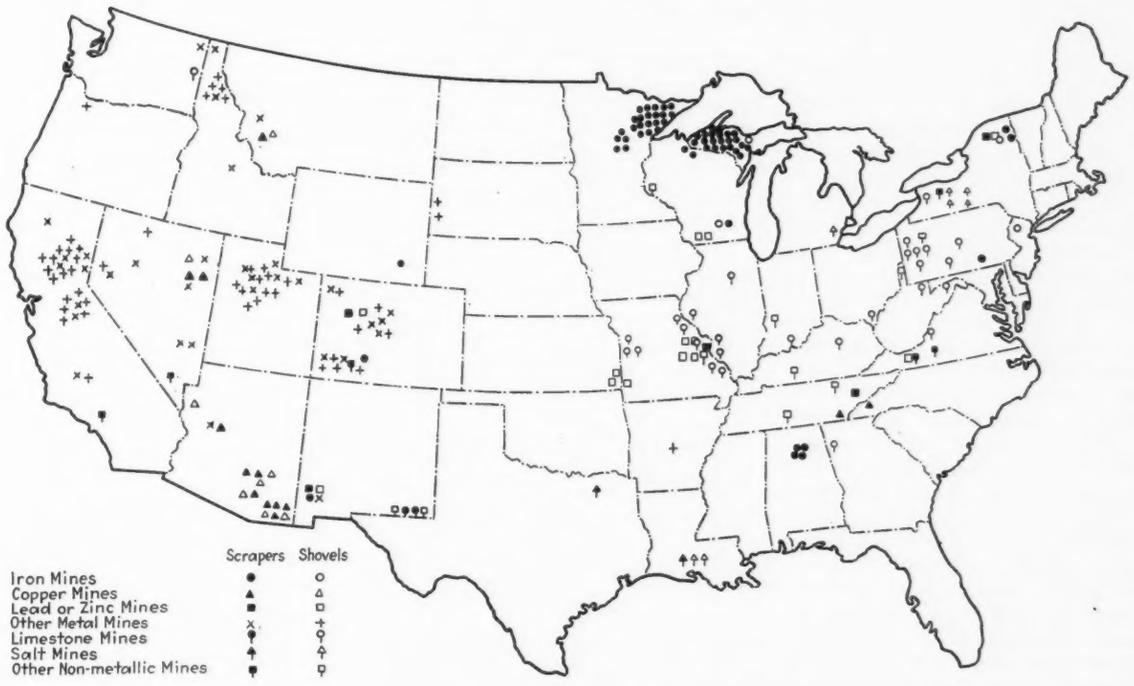
A list of typical compositions and applications of ferrous alloys used in mining and milling on account of their strength, toughness, and ductility is given in Table III.

Other developments in the metallurgy of alloys make more extensive application feasible. Certain of them further improve the structure of the steels and their properties after welding. Joints of columns welded in place and subjected to high hydrostatic pressures must not be brittle, weak, or porous. Suitable welding procedures have been worked out, and also metallurgical improvements, such as the addition of nitrogen, titanium, or columbium to chromium-bearing steels, that will increase strength and ductility, as well as the corrosion resistance of welded joints. Still other developments further the now well-known use of hard-facing.

Metallurgy has made such progress in recent years that operators might well consider whether their present equipment is sufficiently modern from the standpoint of weight-saving and of resistance to wear and corrosion. What might still be done depends largely on the operating engineers' knowledge of the mechanical, chemical, and metallurgical principles and the properties of modern alloys.

Mechanical Loading Underground

. . . A New Survey . . .



Mining companies acquire equipment at increasing rate . . . Bureau of Mines analyses the situation in its relation to stoping methods used

L. N. Plein, F. E. Berquist, and F. G. Tryon

▶WHETHER FOR *replacement purposes, for new and extended application, or to handle a larger tonnage, although probably for all three reasons, more underground loading machines were sold to the mining industry, exclusive of the coal industry, last year, than in any year of record since 1922. Similarly, more scrapers were ordered by mining companies, exclusive of coal companies, than in any year since 1930. These facts are revealed by a survey recently made by the United States Bureau of Mines*[1], *which, however, gives no information as to the capacity of the new units thus acquired by the industry.*

MECHANICAL LOADING with both scrapers and power shovels established itself underground in the metal mines even earlier than in coal mines, and there is a large amount of technical literature[2] on the problems of mining practice which it has raised. Up to the present, however, there have been no statistics to show either the number of machines or the tonnage of ore mechanically loaded. In the coal industry, few subjects have aroused greater interest than the rise of mechanical loading. The number of machines in use in anthracite and bituminous mines has increased from a few hundred in 1923 to about 7,000 in 1936, while the tonnage of the two coals mechanically loaded increased from 2,000,000 to perhaps 70,000,000.

The wide interest in the figures of coal mechanization has prompted the Bureau of Mines to begin a similar inventory of metal mining.[1] This paper is a first product of a more comprehensive survey. The figures presented here are no more than a reconnaissance. The authors will welcome criticism or supplementary data[3].

Some idea of the possible use of underground loading equipment may be gained by reviewing the tonnage

[1] The data in this paper are a byproduct of the study of Mine Mechanization and Productivity made by the U. S. Bureau of Mines in cooperation with the Works Progress Administration National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques. They are published with permission of the Director of the National Research Project and the Director of the Bureau of Mines.

[2] For previous surveys see article by A. M. Gow, *E.&M.J.*, Jan. 31, 1920, pp. 319-337 inclusive. Also article by C. E. van Barneveld, *E.&M.J.*, Sept. 22, 1923, pp. 501-511 inclusive. Also "Mechanical Loading Underground in Metal Mines," by C. E. van Barneveld, a 639-page bulletin published in 1924 by the Missouri School of Mines cooperatively with the U. S. Bureau of Mines.

Table I—Tonnages of Ore Classified According to Mining Methods at Metal Mines Producing $100,000 or More in 1929[a]

Mining Method	Gold Ore, Tons	Copper Ore, Tons	Silver, Lead, and Zinc Ore, Tons	Iron Ore, Tons	Total Tons of Ore	Per Cent of Total Tonnage of Ore	Per Cent of Total Man-Hours of Labor
Underground							
Square-set	379,022	4,318,294	3,121,746	.....	7,819,062	4.6	24.8
Cut-and-fill	13,150	1,573,135	664,252	305,575	2,556,112	1.5	6.8
Shrinkage	5,645,110	2,306,930	2,011,500	1,070,608	11,034,148	6.5	9.0
Open-stope	364,516	6,121,545	15,502,250	13,298,362	35,286,673	20.8	24.6
Top-slicing	.....	.....	.....	15,904,288	15,904,288	9.4	9.1
Sublevel caving	.....	.....	.....	7,303,976	7,303,976	4.3	4.3
Block caving	.....	18,576,196	.....	.....	18,576,196	10.9	7.2
Total underground	6,401,798	32,896,100	21,299,748	37,882,809	98,480,455	58.0	85.8
Surface							
Open-pit	.....	31,605,847	.....	39,883,064	71,488,911	42.0	14.2
Grand total	6,401,798	64,501,947	21,299,748	77,765,873	169,969,366	100.0	100.0

(a) Quoted from C. W. Wright, "Mining Methods and Costs at Metal Mines of the United States," U. S. Bureau of Mines I. C. 6503, p. 5. The 405 mines covered produce 95 per cent of the total output of metallic ore. Figures in short tons.

of minerals, other than coal, now produced by underground mining in the United States.

As to metallic ores, some light upon the question is given by the figures in Table I, which show the tonnage of ores produced by various systems of mining in 1929. Not counting the 71,000,000 tons won from open pits, which represent another phase of mechanization, the table shows a total of more than 98,000,000 tons of ore produced from underground.

Review of the systems of mining used should give some rough conception of the outer limits of possible mechanization. That the limits are necessarily uncertain, any mining man will realize. No two mines are alike, and the statistical groupings conceal a great variety of conditions. Each mine in such a count has to be classified according to the dominant method employed, yet numerous mines make use of more than one method to meet local variation in conditions. Hence the same mine may profitably employ mechanical loading devices in one section and gravity or hand loading in another.

Nearly all mines, on the other hand, produce some ore from development work, and the marked savings in cost or increase in speed often obtained by mechanical loading in drifts and headings indicate that in the future all mines may load some ore mechanically.

With these qualifications in mind, we may examine the data. It appears at once that most of the 7,800,000 tons mined with square-sets is hardly susceptible of mechanical loading, either because of closeness of timbering or other factors. The most that can well be anticipated here, is a gradual shift to other systems of mining, which in some cases may offer greater scope for mechanization[4].

A much larger fraction of the total tonnage, on the other hand, is mined by methods in which the work of loading into cars and even the movement of ore within the stopes are accomplished by gravity. The bituminous coal engineer envies the metal miner his opportunity to tunnel under the mineral and draw it out in this way, and it seems clear that no effort will be spared to make gravity do the work and that the proportion which is produced by block caving and by shrinkage methods will tend to increase. Even here there may be room for auxiliary employment of loading machinery, as scrapers are used at Climax, Colo., in working a massive deposit adapted to shrinkage or caving.

This leaves the tonnages produced by open-stope, top-slicing, sublevel caving (in the Iron Country), and cut-and-fill methods as the chief candidates for mechanical loading. Indeed, in many mines using these methods the application of scrapers or power shovels is far advanced.

The table, however, shows nothing of the large amount of country rock which it is often necessary to handle either in accessory construction or in current development work. Recent experience emphasizes the savings of power loading in the driving of tunnels or headings, whether in rock or ore. The tonnage involved is great, and offers one of the principal fields for mechanical loading below ground.

Finally, we have to reckon with the surprisingly large tonnage of non-metallic minerals now obtained from underground workings. Some idea of the possibilities in this direction is given by the summary in Table II of the quantities of crude material taken from underground in the year 1929. The total is some 18,500,000 tons of non-metallics. Much of this is already mined mechanically and still more is likely to be.

The number of scrapers and shovel loaders respectively acquired by operators of metal and non-metallic mines in each year from 1923 to 1936 inclusive is given in Table III. This information is based primarily upon detailed reports from manufacturers, state mine inspectors, and correspondents in the field.

The total number of machines for the fourteen-year period is placed at 470 shovel loaders and 3,752 scrapers. These figures undoubtedly include many experimental[5] installations which were sometimes only partly successful and sometimes even abandoned. Such cases of partial success or failure are no more than enough to suggest the

Table II—Approximate Tonnage of the Principal Non-Metallic Minerals Produced by Underground Mining, 1929[a]

	Short Tons Mined Underground
Limestone (b)	11,108,317
Gypsum	2,708,711
Rock salt	2,113,010
Clay (b)	786,874
Pyrites (1935)	566,961
Potash (1935)	500,000
Fluorspar	130,000
Phosphate rock (1935)	113,928
Miscellaneous non-metallics	500,000
Total	18,527,801

(a) Wherever possible, figures represent the tonnage of crude material hoisted prior to beneficiation.

(b) Census of Mines and Quarries, 1929, p. 369, p. 393. The figures for clay represent only enterprises whose product was sold as clay, and exclude mining operations of clay-products manufacturers. In addition, 432,866 tons of clay were mined by companies producing from both underground and surface workings at the same operation.

Table III—Scraper Loaders and Shovel Loaders Added to Equipment Underground in Metal and Non-Metallic Mineral Mines[a]

Year	Scraper Loaders (Hoists or Complete Units)	Shovel Loaders
1923	254	57
1924	341	18
1925	373	15
1926	284	38
1927	414	51
1928	363	37
1929	645	58
1930	335	24
1931	126	2
1932	104	14
1933	62	12
1934	67	25
1935	135	47
1936	249	72
Total	3,752	470

(a) Figures pertain to mines in the continental United States, not including those installed by contractors on construction projects. Subject to revision.

[3] The authors are indebted to C. F. Jackson, Chief Engineer, Mining Division; E. W. Pehrson, Metals Division; J. R. Thoenen, George C. Heikes, and H. P. Sweeny, of the Bureau of Mines, for field notes and criticism.

[4] C. W. Wright, "Mining Methods and Costs at Metal Mines of the United States." U. S. Bureau of Mines, I. C. 6503, 1931, p. 32-33.

need of careful study of local conditions and comparison of the alternative types of equipment available before making the investment in loading machinery.

Scraper Loaders—Details of the early installations of scrapers underground will be found in the classic monograph by C. E. van Barneveld cited in Footnote 2. The figures given in Table I pick up the story where Mr. van Barneveld left it in 1923. By that time scraper loading was going forward with a rush. Pioneer installations in the Michigan copper mines and the Lake Superior iron ranges in 1915 to 1917 and in the Tri-State area in 1919 had proved the possibilities of scrapers at a time when shortage of man-power and rising wages focused the attention of managers upon labor-saving devices.[6] In the post-War years, declining prices both of iron and the non-ferrous metals further stimulated the search for cost reduction. Throughout the period from 1923 to 1929, the installation of scraper equipment continued in large volume. Indicative of the savings effected is the record of Gogebic County, Mich., where the output of iron ore per miner per day is reported to have increased from 2.91 tons in 1923 to 5.96 in 1929[7].

By far the largest number of machines were installed in the iron country of Michigan and Minnesota and to a lesser extent in Alabama, the peak being reached in 1929. The great depression fell with exceptional severity on the iron industry, and installations of equipment dropped by 1933 to a small fraction of the former level. Recovery of business sent the curve upward, and encouraging gains were registered in 1935 and 1936. Were it possible to represent the capacity of the equipment rather than the number of units, the progress in 1936 would appear substantially greater, for in the meantime a marked increase in size of the typical scraper hoist had taken place. In 1923, hoists of from 4 to 7½ hp. were the rule. Now they range up to 150 hp., using much heavier equipment and larger scrapers.

As scraper mining has become the established practice in the Lake Superior iron mines, wherever it is applicable[8], future installations in this area will hardly equal those of the 1920's when the mines were being initially equipped. Replacements will of course continue. In Alabama iron mines, scrapers have been widely[9] used, but a considerable part of the district output is still loaded by hand.

In non-ferrous metal mining, one of the outstanding districts that uses scrapers has been the Copper Country of Northern Michigan. Along with power drilling, concentration of haulage, and selective mining, scraper loading has been one of the principal economies that have enabled the Michigan mines to combat the difficulties of increasing depth and to survive in the competitive struggle.[10]

Installations of scrapers by non-ferrous and precious metal mines reached a peak about 1924 and for some years thereafter showed a decline. Beginning in 1935, however, a sudden pick-up occurred, apparently forecasting further activity in this field. A notable feature of the last two years has been the increase in installations by precious metal mines, reflecting the boom in gold production which followed devaluation of the dollar.

Non-metallic mining, like coal mining, has made less use of scrapers than of shovel loaders underground.

Shovel Loaders—Installations of shovel or mobile-type loaders during the same period are shown in the last column of Table III. The record covers two distinct types of equipment. From 1923 to 1931 the installations consisted chiefly of comparatively large units designed for loading in open chambers or stopes. Beginning about 1932, the record is dominated by the smaller type of machines designed primarily for headings or tunnels. Machines of both types have been installed in both periods, but there has been a definite shift of emphasis.

Marked activity in the use of power shovels of the first type had occurred before 1923. The largest number of machines had gone into the Southeast Missouri lead mines. Favorable conditions and progressive management in that field have given it a preeminence in the use of power shovels underground.

The first experiment with a power shovel in the district was made in 1912, but abundance of hand shovelers and the low rate of wages then prevailing were found to yield little incentive to mechanize at that time. The World War, however, forced a reconsideration of mechanical loading. The munitions demand coinciding with the shortage of labor led to the reintroduction of machines in 1917. Improved machines were developed, adapted to the conditions underground, and by November, 1923, a total of 55 power shovels was in use in the field. Since then installation of machines has continued at a less rapid rate and steady advances have been made in the efficiency of operation. In this area mechanical loading has now replaced hand shoveling entirely save for incidental clean-up. An indication of the saving effected is found in the report that in one mine of Southeast Missouri machine mucking requires 0.061 man-hours per ton, and hand mucking 0.416 man-hours per ton.[11]

Power shovels of the larger types were installed in a number of other metal mines. They were also the predominant type of equipment installed for underground loading in non-metallic mineral mines. Installation of the larger types of shovels continued through the great depression, though naturally on a diminished scale.

The last five years, however, have witnessed a remarkable activity in the use of smaller shovels of the second type designed especially for driving tunnels and headings, either in rock or in the vein. Machines for such development work had appeared during and just after the war,[12] but achieved no general acceptance. Improvements seem to have overcome earlier difficulties, and most of the shovels installed from 1934 to 1936 consist of such smaller machines. As the figures in Table III represent number of machines only, without regard to size, the increase indicated is somewhat greater than would appear if figures of daily capacity were available. Installations have been made, of course, in the foreign field also.

On the accompanying map are shown the localities in which scrapers or shovel loaders have been introduced underground. Symbols have been adopted to indicate the kind of mine, as respecting the material mined, these kinds being: iron mines, copper mines, lead or zinc mines, other metal mines, and non-metallic mines.

The map serves, despite a few omissions, to emphasize the following:

1. That in iron mines the scraper has been the dominant type of mechanical equipment used in underground loading. It brings out also that installations of loading machinery have been made in virtually every iron-mining district of the country, though some of the installations were experimental and doubtless not all of them are in active use today.

2. That there is widespread interest in mechanical loading in the mines pro-

(*Continued on page* 254)

[5] *Trans.*, A.I.M.E., Vol. LXXII, 1925, pp. 67, 261, 300, 365, 412. Also U. S. Bureau of Mines Information Circular 6656, 1932, p. 8.

[6] Charles F. Jackson, "Underground Scraping Practice in Metal Mines," U. S. Bureau of Mines Manuscript Report No. 1, Printed by Sullivan Machinery Co., 1933, p. 9.

[7] Handbook of Scraper Mucking, Sullivan Machinery Co., Publication No. 176, 1931, p. 7.

[8] Robert C. Matson: "Scraping Practice in the Michigan Iron Mines," Michigan College of Mining and Technology, Bulletin 1928-1929, Vol. 2, No. 4, p. 1.

[9] Lucien Eaton: "Mechanical Loading in Metal Mines in 1929," *Mining Congress Journal*, July, 1929, p. 536.

[10] Van Barneveld, work cited, p. 337. Also W. R. Crane, "Mining Methods and Practice in the Michigan Copper Mines," U. S. Bureau of Mines, Bulletin 306.

[11] U. S. Bureau of Mines, Information Circular 6170, p. 21.

[12] Van Barneveld, work cited, pp. 10, 11.

LANDING DYNAMITE on the beach at Placer from the lighter offshore

Making a Gold Mine In Mindanao

II

Costs receive careful attention — Production of bullion follows development and equipment

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DURING the original prospecting by the parent syndicate the cheapest possible methods were employed. Equipment consisted of picks, mattocks, shovels, wheelbarrows, hand-drilling tools, a simple blacksmith shop, and a portable assaying outfit.

Much of this early work consisted of open cuts and shallow pits and adits near the surface, in soft ground requiring only occasional drilling and blasting. Underground openings were driven as small as possible, and the timbering that was used where necessary consisted of small drift sets made from round timber cut locally. Slabs were purchased from a sawmill at Surigao at 0.75 to 1 peso per cubic meter, and used for wheelbarrow runways and lagging. The labor cost for short tunnels, mostly driven on day's pay but partly on a contract basis, averaged less than 0.50 peso per foot.

Many trails were cut across the property to get below the top soil and facilitate discovery of outcrop indications. They averaged 1 meter wide and 0.5 meter deep on the uphill side, and the labor cost was approximately 0.013 peso per linear meter.

During the period of increased exploration activity and actual development, starting about November, 1934, and overlapping the mill construction period, the work was made easier by the acquisition of a development plant including three portable compressors, six jackhammers, one stoper, track and cars, a small gasoline-powered hoist, two small sinker pumps, a small steel sharpener and forge, a new assay office, and sundry buildings.

Main drifts and crosscuts, raises, and shafts were timbered with 6x6-in. *yacal,* a durable and strong tropical hardwood costing 75 pesos per M.

Drift sets consist of 7½-ft. posts, beveled at the top to give a batter of about 1½ in. per post, and 6-ft. caps. Instead of dapping the caps at the points of bearing on the posts, 2x6-in. spreaders 5 ft. long are nailed to them before leaving the timber-framing yard. This makes a simple and strong set that can be quickly set up underground, reducing timbering labor costs.

Standard square sets are used in most raises. Dimensions of 4½x4½x 7½ ft. center to center were early adopted, with a view to later use of stope sets of the same proportions.

Shaft sets are ordinarily hung 7½ ft. apart center to center, except where running ground requires shortening of the posts to avoid the alternative of spiling while sinking. A simple one-step framing is standard on shaft sets.

Actual direct costs of underground development during a recent period are given in Table I. These include all direct working face charges for labor, explosives, timber, and other supplies, as well as prorated indirect charges for compressed air, drills and steel, pumping, hoisting, ventilation, supervision, and underground maintenance. General overhead, covering administration, mine-office expense, engineering, and the like, is not included, because to do so would obscure the comparison between costs during the preliminary period when only development was being done (which thus bears all this overhead expense) and costs resulting after stoping operations started (at which time general overhead is less for development be-

cause the added operations bear their share of this expense).

The costs shown in Table I are relatively high, largely because new development work was somewhat curtailed during the period covered, while underground preparation for stoping was being pushed. Increased charges for pumping and hoisting, due to the high proportion of lateral work done below the Mindoro 300 level, and the naturally higher costs of sinking, also tended to raise the average cost per foot during the period.

Table II gives the footage driven and total cost per foot of all development work between Oct. 1, 1934, and March 1, 1936. In this case the figures cover all expenses at the mine, including general overhead but not including capitalized costs of buildings and machinery nor Cebu office expense. This period approximately represents the preliminary development stage of the mine after the original prospecting and up to the time mill construction started.

For the period from Oct. 1, 1934, through June 30, 1936, the cost of driving approximately 16,000 ft. of underground prospecting and development workings, including indirect expense chargeable but not general overhead, averaged about 8.72 pesos per foot. This amount of work developed somewhat more than 85,000 tons of ore, or an average of 5.3 tons per foot of work at a cost of 1.53 pesos per ton developed. It must be noted that these figures include nearly 5,000 ft. of underground prospecting work, much of which, although giving valuable information, was not directly productive in the sense of adding to ore reserves. Inasmuch as the geology of the property is now better understood than when exploration started, it is probable that future development will require less actual footage per ton developed. An allowance of 1.75 peso per ton mined for current development therefore should be sufficient to more than maintain ore reserves in the future.

Ore reserves are formally estimated twice a year. Reserves at the end of 1936 were estimated to be about 100,000 tons.

Mining Methods—The ore is characterized by erratic distribution of values within the vein and by poorly defined and variable walls. Save in a few minor instances no structural walls or other limits bound the stoping ground, and it is necessary to sample all ore exposures closely, especially on margins of the veins, before the ground is broken in the stopes. Furthermore, the wall rocks of the ore are highly altered in most places and are soft and structurally weak. They require close support, and the individual stopes have to be worked rapidly to avoid the need of heavy maintenance charges in levels below, in addition to excessive timbering in the stopes themselves as they are carried upward.

Probably all the ore will be mined by the horizontal cut-and-fill or the horizontal square-set-and-fill method, or a combination of the two. Ore from the stopes above the Mindoro 300-ft. level drops by gravity through a system of ore-pass raises to chutes on the 300-ft. level, whence it is drawn into cars and hand-trammed to the mine bins, which are next to the mill.

Waste for filling the stopes is obtained, in the case of narrow veins, from short inclined raises and crosscuts into the walls which combine the purposes of supplying fill and prospecting the immediate walls for parallel or blind ore. In stoping the wider sections, fill must be introduced through raises connecting with the levels above. This comes from surface excavations during the dry season, from crosscuts in soft picking ground near surface during the wet season, or from current development.

No stoping having previously been done here or elsewhere in the district, we could not base estimated stoping costs on past performance. The estimates were necessarily adapted from the results of drifting and raising done to that date, a close account of underground costs having been kept. Results at other mines in the Philippines, as well as general experience, were also given due consideration.

Costs of stoping during a representative month are given, with all other segregated operating costs, in Table III, and are shown in detail in Table V. For comparison, the cost estimates used in calculating the appropriate mill capacity are given in Table III

Table I—Development Footage and Costs per Foot

March 1—June 30, 1936, Inclusive

Classification	Total Footage	Cost per Foot, Pesos
Drifts and crosscuts (size 5x7 ft., mostly timbered)	599	19.14
Raises (square-set timbering 4½x4½x7½ ft., about half of the raises being two sets wide)	436	18.01
Dogholes (small crosscuts in ore zone, average cross-section about 3x3 ft.)	88	3.65
Mindoro shaft—two compartments, 8x6 ft. outside timbers (cost of sinking between 300 and 400 levels)	97	60.11
Horseshoe winze—two compartment—8½x5½ ft. outside timbers (cost of sinking between 300 and 400 levels)	99	51.83
Prospect adits (drifts and crosscuts, average 4x6 ft., light timbering)	531	3.51
All underground exploration and development, four months	1,850	18.23 (Weighted average)

Table II—Development Footage and Cost

Oct. 1, 1934, and March 1, 1936

Classification	Total Feet	Average Cost per Foot (a)
Prospect adits	3,858	Not segregated for present purposes
Drifts and crosscuts (development)	7,679	
Doghole crosscuts	834	
Raises	1,006	
Shafts	522	
Winzes	224	
Total underground work, 17 months	14,123	13.83 pesos
Prospecting trenches and open cuts, 5,249 lin. ft.		0.57 peso
Prospecting trails, approximately 10,000 lin. ft.		0.04 peso

(a) Total, including general expense at Tinabingan.

Table III—Summary of Costs

October, 1936

Ore milled, 3,296 tons. Gold produced, 868 oz. Cost per ounce, 34.59 pesos

Current charges	Pesos per Ton Milled						Comparison With Estimate Made Before Milling Started			
Operating Accounts direct and redistributed	Labor	Salaries	Supplies	Power	Sundry	Total	Estimated Cost	Actual Cost	Variation Act.:	Est.
Exploration	....	....	....	....	....	....	1.75	0.26	1.49	Less
Development	0.12	....	0.11	0.03	....	0.26				
Stoping	0.92	....	0.95	0.08	....	1.95				
Ore delivery from development dumps	0.17	....	....	....	....	0.17	3.00	2.93	0.07	Less
Mine department, general expense	0.24	0.25	0.27	0.05	....	0.81				
Milling	0.37	0.67	0.71	0.37	0.14	2.26	4.00	2.26	1.74	Less
Tinabingan general expense	0.48	0.86	0.51	0.02	0.74a	2.61	1.75	2.61	0.86	More
Total operating charges	2.30	1.78	2.55	0.55	0.88	8.06	10.50	8.06	2.46	Less
Non-operating accounts										
Bullion marketing expense	....	....	....	....	0.09	0.09	0.15	0.09	0.06	Less
General administration expense, Cebu	....	....	....	....	1.42	1.42	0.85	1.42	0.57	More
Total non-operating charges	....	....	....	....	1.51	1.15	1.00	1.51	0.51	More
Total current charges	2.30	1.78	2.55	0.55	2.39	9.57	11.50	9.57	1.95	Less
Per cent of total	24.1	18.6	26.5	5.8	25.0	100.0				

Actual figure was higher due to booking in October, the last month of the fiscal year, certain lump charges for staff travel, insurance, and taxes that normally will be prorated monthly. The figure given closely represents the proper charge to this month.

Table IV—Development Costs

In Pesos per Foot, October, 1936

Tonnage from development, 195. Footage: Drifts and crosscuts, 68 ft.; raise, 41 ft. Total, 109 ft.

Direct Charges	Pesos per Foot of Development					Pesos per Ton Ore From
Sub accounts	Labor	Salaries	Supplies	Power	Total	Development
Hand drilling	0.08		....	....	0.08	0.04+
Machine drilling	0.30		....	....	0.30	0.17
Blasting	0.08		0.93	....	1.01	0.56
Mucking and local tramming	1.37		....	....	1.37	0.77
Tramming (haulage level)	0.59	Included	....	....	0.59	0.33
Timbering	0.31	with	1.66	....	1.97	1.10
Cabos	0.45	mine	....	....	0.45	0.25
Total direct	3.18	depart-ment	2.59	....	5.77	3.22
Indirect Charges		general				
Redistributed accounts						
Hoisting	0.41	expense	0.06	....	0.47	0.27
Air drills and steel	0.07		0.39	0.78	1.24	0.69+
Machine steel sharpening	0.02		....	....	0.02	0.02
Hand tool sharpening	0.01		....	....	0.01	
Pumping	....		....	....	....	....
Ventilation	....		....	....	....	....
Total indirect charges	0.51		0.45	0.78	1.74	0.98
Total direct and indirect charges	3.69		3.04	0.78	7.51	4.20

Table V—Stoping Costs

Pesos per Ton, October, 1936

Tonnage from stopes only, 1,864; from development, 195; from dumps, 1,202; from bins, 35. Total milled, 3,296

Direct Charges	Pesos per Ton of Ore From Stopes Only					Pesos per
Sub accounts	Labor	Salaries	Supplies	Power	Total	Ton Milled
Hand drilling	0.02		....	....	0.02	0.01
Machine drilling	0.13		....	....	0.13	0.07
Blasting	0.03		0.33	....	0.36	0.20
Mucking (including handling fill in stopes and local tramming)	0.54	Included	....	....	0.54	0.31
Tramming (haulage level)	0.33	with	....	....	0.33	0.19
Timbering	0.41	mine	1.22	....	1.63	0.92
Cabos	0.12		....	....	0.12	1.07
Total direct	1.58	depart-ment	1.55	....	3.13	1.77
Indirect Charges		general				
Redistributed accounts						
Hoisting	....		....	....	....	....
Air drills and steel	0.02	expense	0.13	0.15	0.30	0.17
Machine steel sharpening	0.01−		small	....	0.01	0.01
Hand tool sharpening	0.01−		small	....	0.01	
Pumping	....		....	....	....	....
Ventilation	....		....	....	....	....
Total indirect charges	0.04		0.13	0.15	0.32	0.18
Total direct and indirect charges	1.62		1.68	0.15	3.45	1.95

Table VI—Cost of Excavation and Delivery of Ore from Development Dumps

October, 1936

Tonnage from 50-level dumpage, 639; from Horseshoe dump, 563; total dumps, 1,202

Direct Charges	Pesos per Ton Ore From Dumps					Pesos per
Sub accounts	Labor	Salaries	Supplies	Power	Total	Ton Milled
Mucking and local tramming	0.33	Included	...	....	0.33	0.12
Main haulage tramming (50-level ore)	0.12	with mine depart-ment	....	....	0.12	0.04+
Cabos	0.02		....	....	0.02	0.01−
Total direct charges	0.47	expense	....	....	0.47	0.17

alongside the figures obtained from subsequent operating results.

Ore Treatment—As already mentioned, the method of treatment best adapted to the East Mindanao ore was determined by Messrs. Bagley and Bitzer at Balatoc. They designed the essential features of the flowsheet and certain details were worked out by the company staff.

Space does not permit a detailed description of the milling methods. In the main they are in line with standard cyanide practice. Standard all-slime cyanidation of the finely ground pulp is employed, with agitation in three Dorr agitators, followed by continuous countercurrent decantation through a series of thickeners, final filtration on an Oliver filter, and Merrill-Crowe precipitation. A slime-washing plant is provided ahead of the secondary crusher.

Original estimates were based on the assumption that the plant would make an over-all extraction of 90 per cent. Standard equipment being used and the ore being chemically amenable to cyanidation, no metallurgical difficulty was anticipated. A high content of clay or natural slime was expected to give trouble, but this has not proved serious.

The mill was designed for a nominal capacity of 100 tons per day, at a grind of 80 per cent minus 200 mesh. Good extraction has been made at a coarser grind, which has enabled us to treat 15 to 20 per cent more ore

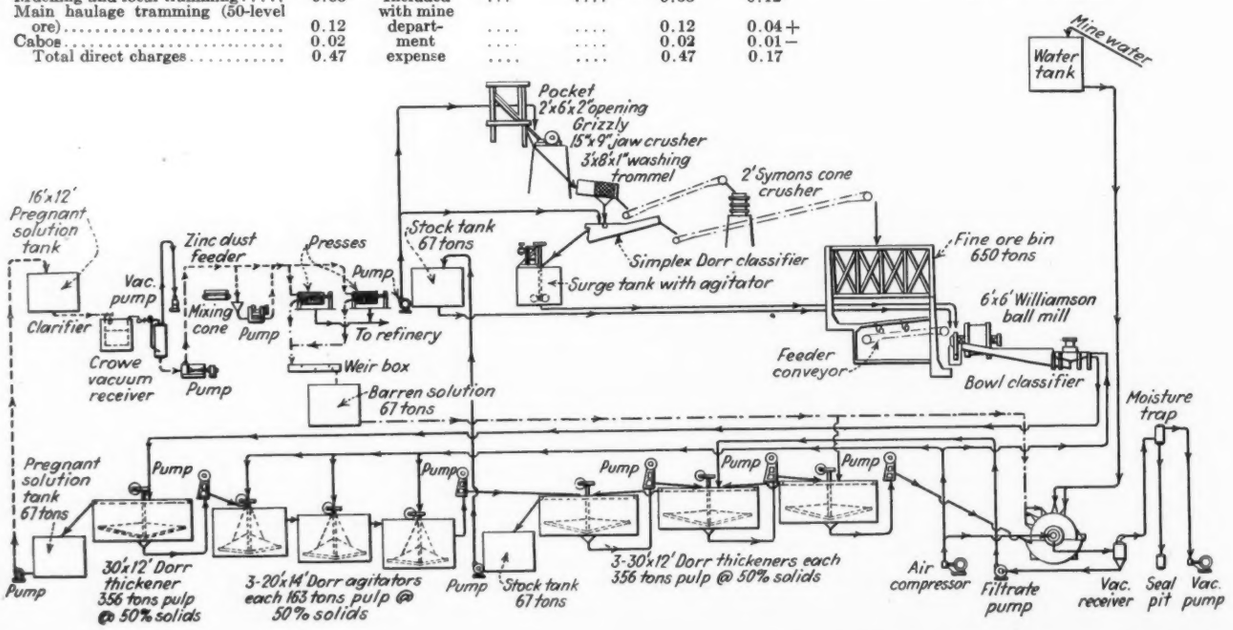

Fig. 1 . . . THE FLOWSHEET of the cyanide plant of the East Mindanao Mining Company. Continuous countercurrent decantation is employed

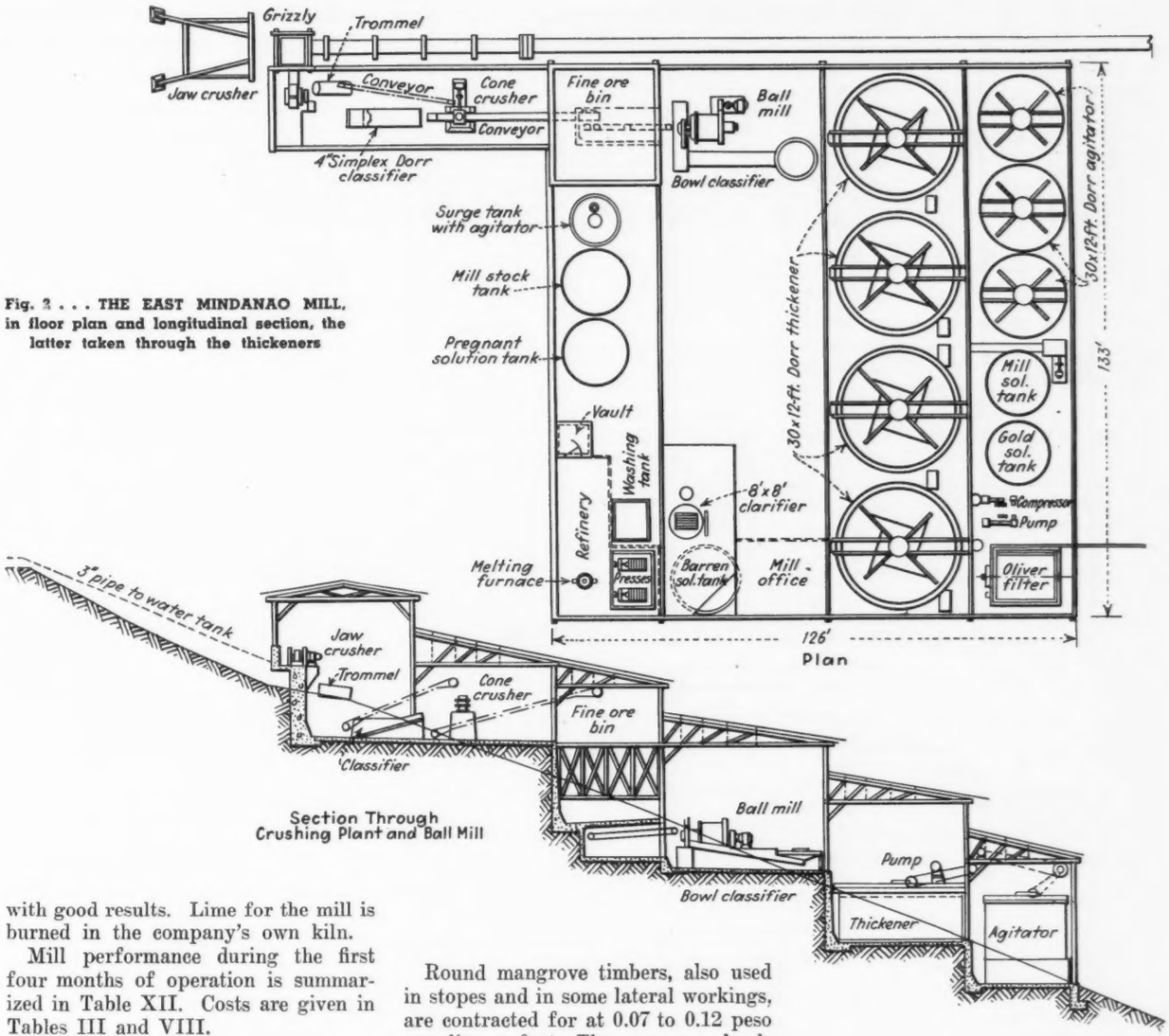

Fig. 2 . . . THE EAST MINDANAO MILL, in floor plan and longitudinal section, the latter taken through the thickeners

with good results. Lime for the mill is burned in the company's own kiln.

Mill performance during the first four months of operation is summarized in Table XII. Costs are given in Tables III and VIII.

Auxiliary Operations—The company now conducts a logging operation to obtain its stope timber. Fifty to one hundred men, under a native *cabo,* fell the trees and whipsaw them into square timbers on contract. Timbers and slabs are piled beside the road and trucked to the yards at the haulage tunnel entrances.

Round mangrove timbers, also used in stopes and in some lateral workings, are contracted for at 0.07 to 0.12 peso per linear foot. The company hauls some of them from more distant sources with its lighter and launch.

Limestone is quarried on a near-by island and transported to the kiln on the beach near the mill by lighter and launch. The kiln is operated continuously on day's pay. Costs of these auxiliary operations are summarized in Table X.

Table VII—Mine Department, General Expense

Tonnage from mine (including dumps), 3,261; mill bins, 35; total milled, 3,296

Direct Charges Sub accounts	Pesos per Ton Mined (Including Dumps)						Pesos per Ton Milled
	Labor	Salaries	Supplies	Power	Sundry	Total	
Supervision	.....	0.241	.....	.....	.....	0.241	0.238
Pipe lines	0.014	.....	0.051	.....	.....	0.065	0.064
Timber and supplies delivery	0.041	.....	.....	.....	.....	0.041	0.040
Maintenance mucking	0.004	.....	.....	.....	.....	0.004	0.004
Maintenance tramming	0.001	.....	.....	.....	.....	0.001	0.001
Maintenance timbering	0.031	.....	0.082	.....	.....	0.113	0.110
Track and ditch	0.008	.....	0.018	.....	.....	0.026	0.025
Car checkers	0.020	.....	.....	.....	.....	0.020	0.020
Cabos	0.010	.....	.....	.....	.....	0.010	0.010
Car repairs and maintenance	0.002	.....	0.005	.....	.....	0.007	0.007
Miscellaneous (including timber framing)	0.073	.....	0.062	.....	.....	0.135	0.133
Total direct charges	0.204	0.241	0.218	.....	.....	0.663	0.652
Indirect Charges							
Redistributed accounts							
Pumping (maintenance of temporarily idle level)	0.035	0.015	0.061	0.049	.....	0.160	0.158
Total indirect charges	0.035	0.015	0.061	0.049	.....	0.160	0.158
Total direct and indirect charges	0.239	0.256	0.279	0.049	.....	0.823	0.810

Operating Plant — The principal equipment used in the earlier stage of development has been mentioned. Later additions were made to facilitate development, after it was known that a mill would be built.

The major items, as at the end of October, 1935, are listed in Table XIII. Additions made during 1936 are itemized in Table XIV. Unfortunately, detailed costs of plant installation cannot be given, because the data needed have become mislaid, thanks to the recent shipping strike. The total costs of plant and equipment, taken from last year's balance sheet, are given in Table XV.

A major factor in deciding to contract the work of building the mill was the fact that additional financing would have been required had the company decided to build the plant on its own account, whereas the contractor was willing to take his payment in installments after milling began. This saved several months, and left the company with sufficient resources to

Table VIII—Milling Costs

October, 1936. Tons milled, 3,296

Direct Charges Sub accounts	Pesos per Ton Milled					
	Labor	Salaries	Supplies	Power	Sundry	Total
Hoisting	0.133	.....	0.011	(a)	.....	0.144
Crushing and washing	0.092	.....	0.054	0.106	.....	0.252
Grinding and classification	0.048	.....	0.006	0.134	.....	0.188
Thickening	0.006	.....	0.007	0.031	.....	0.044
Agitation	0.001	.....	.....	0.031	.....	0.032
Filtration	0.027	.....	0.003	0.039	.....	0.069
Clarification and precipitation	0.011	.....	0.035	0.023	.....	0.069
Refining	0.003	.....	0.104	.....	.....	0.107
Water supply	.....	.....	.....	0.008	.....	0.008
Chemicals and reagents	0.005	.....	0.462	.....	.....	0.467
Sampling and assaying	0.020	.....	0.008	.....	0.138 (b)	0.166
Superintendence	.....	0.637	.....	.....	.....	0.637
Miscellaneous	0.023	0.030	0.018	.....	.....	0.071
Total direct charges	0.369	0.667	0.708	0.372	0.138	2.254

(a) No electric power charged to hoisting this month, because temporary steam hoist still in use due to delayed shipment of electric hoist. Boiler fuel included under supplies and labor.

(b) Assay office charge.

finance mine preparation and initial operation without issuing additional stock. These factors justified the rather high price for the building and erection contract.

Discussion of Costs—Direct costs of early development were moderate, due to the favorable circumstances of soft ground—much of which could be picked without blasting—and to the small size of the white staff. Only one trained white man at first, and later two, were on the property during the first year of exploration and development.

Costs of operation after milling began have worked out about as one would expect under the conditions. As compared with a similar operation in the United States, East Mindanao costs for labor are low, due to lower wage rates. Offsetting this, however, are much higher charges per ton for supervision. The relatively poor quality of labor calls for very close supervision.

The higher salaries paid to Americans on the job as compared with those prevalent in the United States, plus the added expense of travel, combine to increase supervision charges. Because of the recent mining boom in the Islands, it has been almost impossible to secure good shift bosses locally, and it has been found by sad experience that the lower-priced "beach combers" are nearly always worse than useless. Unfortunate illnesses caused several staff separations, increasing the costs on account of the travel expense of new men and hampering operations during the period of short-handedness. The staff problem at an isolated small mine in the Islands is indeed a major one.

Supply costs at East Mindanao are not excessive, but a large inventory must be carried. Prices of a few major items are shown in Table XI. To make these figures more useful for comparisons, local Island freight is not included. Actually, freight charges

Table IX—Totals of Sub Accounts Constituting Tinabingan General Expense

October, 1936. Tons milled, 3296

Sub accounts	Pesos per Ton milled
Administration	0.455
Mine-office expense	0.201
Postage and telegrams	0.011
Engineering	0.054
Sampling	0.038
Assaying	0.382
Travel	(a) 0.091
Hospital	0.064
Legal expense at mine	0.006
Lights	0.002
Surface buildings and ground maintenance	0.030
Camp water supply	0.020
General miscellaneous	0.035
Roads, bridges, and trails maintenance	0.022
Tools	0.012
Undistributed shop expense	0.154
Bodega (warehouse) expense	0.098
Policing	0.042
Workmen's compensation charge	0.007
Boats, lighters	0.037
Trucks, autos, and livestock	0.098
Miscellaneous fees, licenses	0.009
Freight and handling	0.152
Timber-yard expense	0.029
Consultation expense	0.091
Wharf maintenance	.....
Taxes	(b) 0.441
Fire insurance, monthly charge	(a) 0.025
Total	2.606

(a) Charges during October for travel (paid and accrued) and for fire insurance were actually larger than the figures given, inasmuch as they had not been charged off during preceding months. The figures given represent approximately the correct prorated monthly charge for these items.

(b) Taxes includes bullion production tax. This item will probably be much greater in the future, as the new output tax law had not become effective at Oct. 31, 1936.

Table X—Summary of Costs. Auxiliary Operations

(Distributed to Direct Accounts)
October, 1936. Tonnage milled, 3,296

Account	Pesos per Ton Milled	Remarks
Power	0.560	Cost, 0.0147 pesos per kw.-hr. Operation only. Amortization of plant is carried in general depreciation charge, but if charged to power generation over ten years would roughly double the power cost, of course relieving the general depreciation charge correspondingly
Limestone quarry	0.071	Quarry cost, 4.39 pesos per ton burned lime produced. All work is by hand
Lime kiln operation	0.178	Lime kiln cost, 10.95 pesos per ton burned lime produced, using two low-pressure burners and diesel fuel oil
Logging operation	0.282	Produced 6,833 linear feet slabs at 0.01 pesos per foot. Produced 28,220 bd. ft. whipsawed mine timbers at 0.032 pesos per bd. ft.

Table XI—Prices of a Few Major Items of Operating Supplies Approximate Averages Paid During 1936

	Pesos	
Dynamite, 40% gelatin, per 100 lb.	29.50	c.i.f. Cebu
Steel rails, 16 lb., A.S.C.E. Section, European	70–90.00	f.o.b. Manila
Mine timber, durable yacal, per M	75.00	Local sawmill
Mine timber, soft woods, for stopes, per M	30–45	Local and company sawn
Mine timber, round *manglar*, 5 to 8 in. diameter, per linear foot	0.07–0.12	Local contract
Mine ties, locally hand hewn, per 3-ft. piece	0.06	
Slabs for lagging, etc.	0.01	Company pay
Slabs for lagging, etc.	0.015	Sawmill
Timber wedges, local sawmill, per piece	0.015	
Shovels, No. 2 rd. pt., Red Edge, per doz.	36.00	f.o.b. Manila
Wheelbarrows, pressed steel, per doz.	36.00	f.o.b. Cebu
Carbide, local purchase Cebu, per 100 lb.	9.50–10.00	
Carbide, large contract lots, c.i.f. Cebu, per 100 lb.	7.60	
Cyanide, contract lots, c.i.f. Manila, per lb. KCN equivalent	0.125	
Lime, locally burned, per ton, approx.	15.35	
Lime, f.o.b. Manila, 60% CaO	35.00	
Diesel fuel, Texaco gas oil No. 1, bulk lots delivered our tank, contracted, per ton at	37.50	
Chrome-steel grinding balls, Krupp, per long ton, depending on sizes, c.i.f. Manila	56–60.00	

Table XII—Results of Mill Operation

Aug. 25 through Dec. 31, 1936

	August	September	October	November	December
Operating time, % of possible	22	83.75	94.7	73.82	95.0
Cause of delay	Mechanical adjustments	Repairs to washing plant	Minor adjustments	Major repairs to washing trommel	Normal
Tons milled	677	2,420	3,296	2,602	3,481
Tons per day	.....	80.6	106.3	86.7	112.7
Tons per 24 hours to actual operation	99	96.5	112.0	117.5	118.3
Mill heads, pesos per ton	.....	17.25	21.80	22.52	23.04
Tailing, pesos per ton	.....	1.37	1.74	1.56	1.57
Gold produced, oz.	None—plant absorption	509.2	868.3	779.2	1,064.7
Silver produced	Do.	129.2	233.1	203.0	.....
Recovery, per cent	.....	87.4	91.87	93.07	93.2

The entire August tonnage was required to take care of plant absorption. The delays in September and part of October were chiefly due to shutdowns of the washing trommel, on account of the bearing bases working loose in their foundations. This condition became so aggravated that the plant was shut down for a week in November so that the trommel could be completely reinstalled.

Table XIII—Major Items of Equipment Used During Development Period as at Oct. 31, 1935

Mining Plant
- 1 25-ft. headframe, Mindoro shaft
- 1 35-hp. gasoline hoist
- 2 370-cu.ft. Gardner-Denver portable air compressors
- 1 185-cu.ft. Ingersoll-Rand portable compressor
- 1 Gardner-Denver drill-steel sharpener
- 1 Gardner-Denver oil-fired forge
- 6 I.R. Jackhamer rock drills
- 2 Gardner-Denver stoper drills
- 2 I.R. No. 73 diggers
- 10 20-cu.ft. mine cars
- 1 mine timber truck
- 1 27-g.p.m. Cameron air-driven sinking pump
- 1 48-g.p.m. Cameron air-driven sinking pump
- 2 small Worthington steam pumps (old equipment from former owner of property)
- 1 Coppus Ventair blower, 8 in.
- 1 Champion blower, 8 in., with 3-hp. Fairbanks-Morse gasoline engine
- 1,000 ft. 8 in. G. I. ventilating pipe
- 300 ft. 8 in. canvas ventilating tubing
- Track, pipe, hoisting cable, miners' hand tools, wheelbarrows, and miscellaneous small equipment.

Laboratory Equipment
- 1 5-hp. Fairbanks-Morse gasoline engine
- 2 Braun sample crushers
- 2 Braun sample pulverizers
- 1 Denver Fire Clay No. 4411 oil-fired assay furnace
- 1 small gasoline assay furnace, portable type
- 1 pulp balance
- 1 Ainsworth assay balance
- 1 Heusser assay balance
- 1 acetylene generating set and numerous miscellaneous items of assaying equipment

Shop Equipment
- 1 lathe
- 1 drill press
- 1 power hacksaw
- 1 power grinder
- 1 3-hp. Fairbanks-Morse gasoline engine
- Customary shop hand tools, anvil, coke forge, etc.

Water Supply
- 1 small Goulds Pyramid pump
- 1 1½-hp. Fairbanks-Morse gasoline engine
- 1 3,000-gallon redwood tank

Electric Light Plant
- 1 3-kw. d.c. generator, 110 volts
- 1 3-hp. Fairbanks-Morse gasoline engine

Miscellaneous Equipment
- Under this heading may be included:
- 3 barotos (outrigger canoes)
- 1 lighter, 14 x 30 ft.
- 1 small launch
- 1 Ford V-8 1932 station wagon
- Engineering instruments
- Office equipment

are carried on a separate account at this mine, as they constitute a major item which it is deemed best not to obscure by distributing it to stock costs. Freight bills are slow in coming in (most of the local shipping is controlled by Chinese), and to include them in supply accounts would often delay the monthly cost statements. Cost of freight is given as a sundry item of Tinabingan General Expense.

Power costs per ton are moderate, because of efficient modern machinery, relatively low requirements of the mining department, and gratifying results of the operation of the diesel power plant.

In comparing actual with estimated results (Table III) one should note that development and exploration charges were abnormally low in October because in starting up the new operation all efforts were devoted to bringing the mine to a routine producing condition, and development was temporarily greatly curtailed. This item, it is thought, will approach the estimated figure of 1.75 pesos per ton in 1937.

Table XIV—Additional Major Equipment Acquired During 1936 as at Oct. 31, 1936

Mining Plant
- 6 additional R-39 Jackhamers
- 1 additional H-81 stoper
- 12 additional 20-cu.ft. mine cars
- 2 Ingersoll-Rand 5-hp. motor-driven centrifugal pumps, 100-gal. capacity
- 1 Chicago-Pneumatic Utility compressed air-driven mine hoist having a 1,000-lb. rope pull
- 1 600-cu.ft. Type XCB Ingersoll-Rand two-stage air compressor, V-belt driven by a 125-hp. Allis-Chalmers synchronous motor

Laboratory Equipment
- 1 additional D.F.C. No. 4411 oil-fired assay furnace
- 1 electric hot plate
- Miscellaneous glassware and assaying equipment
- 1 5-hp. electric motor for driving sample crusher and pulverizers

Shop Equipment
- 1 5-hp. electric motor for driving shop machinery

Power Plant
- 2 300-hp. Worthington diesel engines direct-connected to two 200-kw. General Electric generators operating at 480 volts
- Standard switchboard equipment, including two distribution panels for mill circuit and mine and general surface circuits
- 1 Sharples centrifuge for clarifying fuel oil and lubricating oil
- 2 Worthington motor-driven centrifugal pumps for circulating the engine cooling water
- Cooling tower with necessary piping, fittings, etc., sufficient to handle the cooling water requirements of the two engines and the 600-ft. mine compressor

Fuel Oil Storage Installation
- 1 30,000-gal. steel storage tank near the power house
- 1 3-in. pipe line about 1,500 ft. long from the storage tank to a position offshore in deep water where connection is made to the discharge pump of a small oil tanker
- 2 Roper centrifugal transfer pumps
- 4,000-gal. steel tank to be used for clean oil storage after centrifuging
- 2 oil flow meters

Mill Water Supply Installation
- 1 16 x 16-ft. redwood mill-water storage tank situated above the mill
- 1 300-ft. 3-in. pipe line supplying this tank from the supply sump at the portal of the Horseshoe tunnel (Mindoro 300 level adit)
- 1 Gould's Pyramid pump, size 5 x 4-in., belt-driven by one 5-hp. General Electric induction motor

Lime Kiln
- A steel-jacketed lime kiln having an estimated minimum capacity of 1 ton of burned lime per day. It utilizes fuel oil in two burners of the medium pressure type connected to one D.F.C. 250 blower.

Lime Quarry
- A small loading dock has been built at the lime quarry on Dinago Island.

Milling Plant
- Details of the mill building and mill equipment are shown on the flowsheet and general layout, Figs. 1 and 2

Miscellaneous
- 1 additional lighter, deck 20x40 ft., 60-ton capacity (sold after completion of plant construction)
- 1 Ford truck, 1½-ton nominal capacity

Milling of existing dumps naturally lowered the over-all cost of ore sent to the mill as compared with what this cost would have been if all the mill feed had been stoped. Exhaustion of the dumps at an early date will remove this favorable influence on costs, but we believe that actual stoping will be sufficiently cheaper to offset any increase in ore cost—partly because of increased efficiency and partly because the cost of chutes, sill floor timbering, and similar items, which is included in the October stoping cost figures, will be proportionately much less. Most of the mine production in the early months came from a relatively large number of stopes that had been newly started.

Table XV—Cost Value of Plant as at Oct. 31, 1936

	Pesos
Buildings	147,815.79
Plant structures other than buildings	26,497.84
Machinery and equipment	334,192.00
Boats and lighters	3,632.04
Trucks, autos, and livestock	3,051.05
Furniture and fixtures	6,670.52
Roads and bridges	7,334.77
Limestone quarry	1,143.96
Total	530,337.97

Mine department expense includes charges for American underground supervision, all new track and pipe work, and maintenance. At this mine the best idea of detailed working costs is obtained by segregating overhead items from direct working face costs rather than by obscuring the latter by an arbitrary, laborious, and almost meaningless accounting distribution of such charges. The same reasons led us to carry engineering, assaying, sampling, much of the shop expense, and other items often distributed to direct working costs, as items of Tinabingan General Expense (Table IX). Thus this account is higher than at many mines, but at East Mindanao it was found expedient to keep such charges separate and intact in this manner because it enabled the management to scrutinize them more effectively. It also simplified the work of accounting considerably.

Due to the isolation of the property, a large stock of operating supplies must be maintained. On Oct. 31, 1936, supplies on hand at the mine were valued at 54,361.09 pesos.

In conclusion one should note that the estimated costs were based on a milling rate of 100 tons per day, whereas in October the plant treated about 106 tons. This naturally reduced the per ton cost of many virtually fixed items such as supervision, mill and surface labor, some supplies, all taxes except output tax, and head office expense, by about 6 per cent of what they would have been on a 100-ton basis.

The administrative and operating staff at the end of 1936 consisted of H. Gasser, president and general manager (at Cebu); J. B. Knaebel, mine manager (now on vacation); John Smeddle, acting mine manager and mill superintendent; Lloyd Conklin, mine superintendent; J. C. Thomson, master mechanic; R. C. Meaders, Carl Gustafson, and J. E. Eckman, mill shift bosses; G. E. Fassler, assayer and mine engineer; and H. Alther, accountant. C. E. Chaffin was engaged on a temporary basis in April, 1936, to act as metallurgist and superintend initial operation of the mill. He left the employ of the company in November, 1936. Mr. Gasser has kindly granted permission for the publication of this article.

Measuring Contact Angles

For the Bubble Machine

A NEW DEVICE

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FOR MEASURING contact angles, Taggart, Taylor and Ince[1] and Wark and Cox,[2] in their work with the bubble machine,[3] used a transparent protractor and a straightedge. This method, although fairly accurate for the purpose of flotation testing, is somewhat clumsy in manipulation.

A new contact-angle measuring device, although not much more accurate, constitutes a distinct improvement over the older method made at relatively small cost. This new instrument is shown in Fig. 1.

As might be expected, the instrument consists primarily of a 6-in. xylonite (transparent) protractor graduated in degrees from 0 to 180, with two scales running in opposite directions, as shown in Fig. 1. This is desirable because angles must be measured at both points of three-phase contact,[3] and if two scales are available on the protractor, values of contact-angles may be obtained directly.

Onto this protractor is screwed a brass ring (Fig. 2) which houses a gear-ring. The gear-ring has screwed onto it a xylonite disk on which cross hairs have been drawn on the lower surface. The bottom supports for this gear-ring consist of a number of washers placed at the points where the outer brass ring is screwed onto the protractor. These washers prevent scratching of the protractor surface.

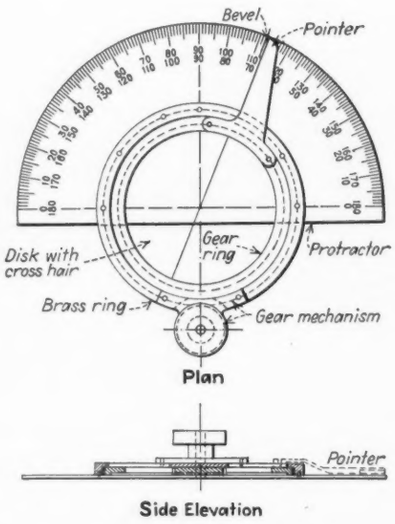


Fig. 2 . . . THE TWO SCALES on the improved protractor facilitate the measuring of contact angles when using the bubble machine

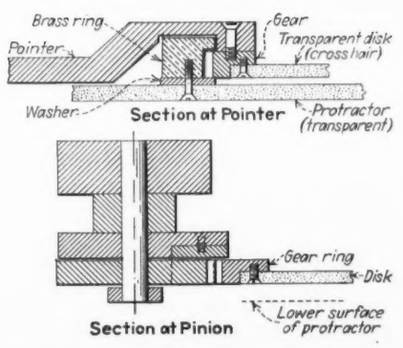


Fig. 1 . . . A GEAR RING housed in a brass ring and carrying two cross hairs is screwed on to the protractor. The intersection of the cross hairs must coincide with the origin on the protractor

It is clear, of course, that the intersection of the cross hairs on the disk must coincide with the origin on the protractor. The brass pointer is screwed onto the gear-ring as shown in Fig. 2. The gear-ring is actuated by a smaller gear disk (bronze), called pinion here for simplicity, mounted onto the outer brass ring as shown in Figs. 1 and 2.

Acknowledgment is made to George Wyland, who so carefully carried out the plans in constructing the instrument and at the same time gave valuable suggestions.

[1] A. F. Taggart, T. C. Taylor, and C. R. Ince: "Experiments With Flotation Reagents." *Trans.* A.I.M.E. (1930) 87, Milling Methods, 285.

[2] I. W. Wark and A. B. Cox: "Principles of Flotation—An Experimental Study of the Effect of Xanthates on Contact Angles at Mineral Surfaces." *Trans.* A.I.M.E. (1934) 112, Rocky Mountain Fund Volume on Milling Methods, 189.

[3] G. R. M. del Giudice: "The Bubble Machine for Flotation Testing." *E.&M.J.* (1936) 137, No. 6.

Screw press used for manufacturing tamping cartridges at the Anaconda Copper company's plant at Butte, Mont.

For Greater Safety in Blasting Practice

TAMPING drill holes is perhaps one of the most dangerous phases of blasting practice, and serious accidents occur frequently when men tamp the material in the drill hole too vigorously or carelessly tamp with iron rods. Recognizing the hazards attendant upon conventional tamping methods, the engineering research department of Anaconda Copper Mining Company, Butte, Mont., after a careful study of the problem, evolved the method now used at all its mines in the Butte area, which speeds blasting operations and provides increased safety.

Explained briefly, issuance of material in bulk to the men for tamping drill holes underground has been discontinued, and instead they are provided with special tamping cartridges manufactured on the surface in the simple manner shown in the accompanying illustration.

The cartridges used in this manner are loaded with clayey tailings from the Timber Butte mill by an old du Pont dynamite screw press, the paper shells being of a different color than those containing dynamite or powder, to avoid possible mistakes. The tailings are fed into the conical cast-iron bowl or hopper, to be disintegrated by a simple stirring mechanism, and are pressed into the paper shells attached to the protruding holders on the flange bolted to the screw casing by two screws, the feeding of the shells being controlled by a manually operated lever.

Profit From Mineral Waste

Tri-State Tailings

Yield Commercial Products

HUGE PILES of chats or tailings "dot" the landscape of the Tri-State zinc-lead district when seen from an airplane, as this aerial photograph shows. Seen from the surface they merely obstruct the view. Here is a small portion of the Picher area. In the aggregate the tonnage of such material is large.

F. W. Netzeband
Mining Geologist
Joplin, Mo.

IN RECOVERING the zinc-lead minerals of the ore of the Tri-State mining district of Oklahoma, Missouri, and Kansas, vast piles of waste rock are produced. The aggregate production of zinc and lead concentrates from the time of the first discovery of lead near Granby, Mo., in 1848, to the end of 1935 has been more than 19,000,000 tons. This output, it is estimated, has required the milling of 330,000,000 tons of ore, which, after removal of the zinc and lead minerals, left 310,000,000 tons of waste rock or tailings. Much of this has already been used for one purpose or other, but a conservative estimate indicates that about 200,000,000 tons is still available. Lest the reader get an erroneous idea of the amount of commercial material contained in this, he should note that, though most of the tonnage specified could be used for railroad ballast or surfacing secondary and farm roads, the quantity that can be put to special industrial uses is much smaller. This is due to the character of the rock minerals and the mineral impurities such as calcite, dolomite, shale, marcasite, chalcopyrite, and the unrecovered portion of the zinc and lead minerals.

The Tri-State district comprises the southwestern part of Missouri, the southeastern part of Kansas, and the northeastern part of Oklahoma. The mineralized area in Missouri is more widespread and covers a larger territory, but the Oklahoma-Kansas section has been the richest, though concentrated in a smaller area, as shown in the map in Fig. 1. The aërial photograph shows a small part of the Picher area, in Oklahoma, and gives an idea of the way in which the huge piles of mine waste are distributed. In size these piles range from a few thousand tons to as much as 4,000,000.

Probably the earliest use made of this material was for surfacing roads around the mines and as ballast for the spur tracks that form a network over the mining area. The railroads soon realized that these "chats," as the tail-

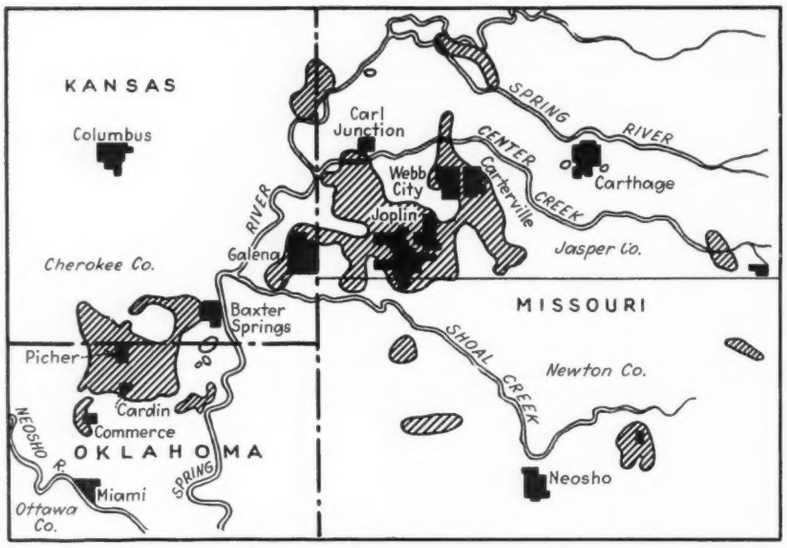


Fig. 1 . . . THE MINERALIZED AREA of the Tri-State district is more extensive in Missouri than elsewhere, as shown by this map, although the Oklahoma-Kansas portion has been the richer

ings are called locally, were ideal for ballast and extended their use to main-line tracks. From mine roads, their use soon spread to the public roads, until today there are few "dirt" roads in the areas readily accessible to a tailings pile. The use of chats in concrete for piers at the concentrators was soon extended to other forms of concrete, until today a large tonnage is so consumed. As time progressed, other uses were developed, but most of these require careful processing. The use of chats in competition with other materials is limited by the cost of transportation. Except for making some of the specially processed products, their movement is limited to a radius of 150 to 200 miles.

Some knowledge of the geology and minerals of the ore deposits is necessary to a better understanding of the character of the material available. The surface rocks east of Spring River are the limestones and cherts of the Boone formation, of Mississippian age, with occasional outliers of Pennsylvanian shale filling depressions in the Boone. Just west of Spring River is a narrow belt of Chester limestone, the youngest Mississippian formation. Elsewhere in the Oklahoma-Kansas area the Pennsylvanian shales are exposed at surface.

Except in a few instances, the orebodies are found in the chertified parts of the Boone formation. The ore occurs at several horizons, but most of it in the Oklahoma-Kansas section has come from two of these, designated as the "K" and "M" beds by G. M. Fowler.[1] In the Missouri area a large tonnage of the ore has come from the "sheet-ground" horizon, the "O," "P,"

[1] "Chertification in the Tri-State Mining District." A.I.M.E. *Trans.* Vol. 115, 1935, p. 110.

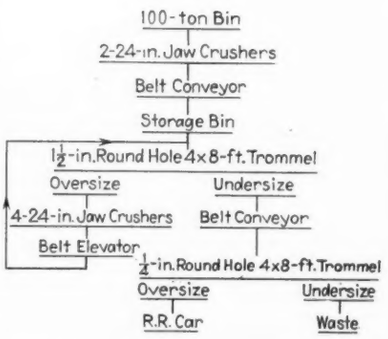


Fig. 2 . . . TYPICAL FLOWSHEET of a Tri-State plant for producing crushed rock from mine waste. Two grades are made in the district, both of which are used as coarse aggregate for concrete work

"Q" beds of Mr. Fowler. The beds between are limestone or barren cherts. In some mines the Pennsylvanian shales have come down through crevices and larger openings in the rocks and are sometimes found redeposited in the ore beds.

The ore minerals are sphalerite (zinc sulphide) and galena (lead sulphide). The gangue minerals are various colored cherts, white, gray, blue, or black; gray or black jasperoid, which is a metasomatic replacement of the limestone by silica; calcite; dolomite; and, in some mines, shale. These gangue minerals are found in varying quantities in different mines, and the use to which the chats in a particular pile can be put depends upon those that are present. Marcasite, an iron sulphide, is also present in varying quantities, in some mines being so abundant that it cannot be kept out of the zinc concentrate. The chats from such a mine are heavily stained with iron from the oxidation of the sulphide. Minor quantities of pyrite, another form of iron sulphide; chalcopyrite, a copper-iron sulphide; and the oxidized products of the sulphides are present. Though the quantity of these contaminating minerals is usually small, their presence may prohibit the use of the chats for a particular purpose.

The Products and Their Uses—The materials handled by the rock products companies cover all sizes from "two-man" boulders (weighing 150 to 200 lb., which require two men to handle) to rock dust, the major part of which will pass a 200-mesh sieve.

Boulders—In mining the zinc-lead ore, areas are found underground in which the chert has been broken and then loosely cemented by calcite or ore minerals. The chert itself is often barren or contains so few values that it would be unprofitable to mill it. As much as possible of this lean material is culled in the mine, but often there is not enough room underground to dispose of it readily, so it must be hoisted to the surface. After being hoisted, the ore is dumped upon a grizzly with 6- to 8-in. openings, the undersize dropping into a hopper. The oversize is "sledged through" by men who also cull out the barren or lean boulders. These are the source of the rip-rap shipped from the district and are mostly confined to "one-man" sizes (10 to 12 in. maximum dimensions, weighing 75 to 100 lb.) and running approximately 22 cu.ft. to the ton. They are used extensively for protecting railroad embankments, in preventing stream-channel erosion, and a small proportion goes to make rubble concrete. The use of such boulders at any point is definitely limited by the availability of local materials.

Crushed Rock — Two kinds of crushed rock are produced: one in which all must pass a 2- or 2½-in. screen and the other in which all must pass a 1- or 1½-in. screen. The first is used as coarse aggregate for concrete pavements and the second as coarse aggregate for concrete structures such as bridges and culverts. The 2½-in. rock weighs about 2,250 lb. per cubic yard. See Table I.

Table I—Typical Screen Analysis of Crushed Rock

Size	Percentage			
	1 (*a*)	2 (*a*)	3 (*b*)	4 (*b*)
Minus 2½-in. mesh	100	.....	.....	.....
Minus 2-in. round hole	.....	.....	100	.....
Minus 1½-in. mesh	60-95	100	.....	100
Minus 1-in. round hole	.....	.....	30-60	.....
Minus ¾-in. mesh	40-75	40-75	.....	20-50
Minus ½-in. round hole	.....	.....	5-20	.....
Minus ¼-in. mesh	0-5	0-5	0-5	0-5

(*a*) Kansas Highway Department specifications.
(*b*) Missouri Highway Department specifications.

This crushed rock is reported to be superior to river gravel, because the angularity of the fragments increases the stability of the concrete, due to the interlocking of the particles and the smaller sizes of the voids. It is also reported to be superior to crushed

limestone for use in pavement, because its greater hardness increases the wearing qualities of the concrete.

"Bank Run" Chats—These are the unprocessed tailings, just as produced by the mills. The screen analysis varies with the type of ore milled. Free-milling ore sometimes is crushed as coarse as ¾ in., although the general practice is to crush to ½ or ⅝ in. Kansas State Highway specifications call for material all of which will pass a ¾-in. screen with 85 per cent retained on a 30-mesh screen. The modulus of fineness should be not less than 4.25. This material weighs approximately 93 lb. per cubic foot, or 2,500 lb. per cubic yard. See Table II.

Bank-run chats contain enough fines so that the material packs well and is ideal for use in such places as farm driveways and barnyards. Its successful use on roads depends upon the character of the earth base. It works best with clayey soils which furnish the needed binder. With sandy soils it does not pack so well and tends to make a heavy road.

This material should receive further study as to its possibilities for plant-mixed, stabilized road surfacing, although the washed chats probably are superior for this purpose. Mixed with the proper proportions of fines and clay, bank-run chats might make an ideal surfacing for low-cost secondary roads.

Washed Chats—This type of chats is composed of material from which all minus-100-mesh material has been washed. The washing also removes many of the impurities, such as the metallic minerals and shale, leaving a clean product. Washed chats weigh about 92 lb. per cubic foot, or slightly less than the bank-run.

Kansas State Highway specifications for this material require all of it to pass a ¾-in. screen and not more than 15 per cent to pass a 30-mesh screen, the modulus of fineness to be not more than 4.50 or 5.00. See Table III.

Washed chats have a number of uses, but between 80 and 85 per cent is used for railroad ballast. This product is ideal for the purpose because it is easily tamped by hand in laying or realigning track, does not tend to pack, drains well, and therefore is not subject to volume changes during alternate periods of freezing and thawing. Also, it keeps down growth of vegetation and, when oiled, prevents dust and reduces gullying from rainfall. Over a million tons annually have been used for ballast during the past three years.

All railroads entering the district use this chat ballast, and, because of a favorable freight rate into Kansas City, those entering there now use it. Washed chats also make a superior material for surfacing earth roads, because the removal of the fine chert particles allows the voids, which otherwise would be filled with chert fines, to be filled with earth of the road base. This clay or other soil acts as a binder and makes a more stable road. Washed chats should be desirable for making a plant-mixed, stabilized, road-surfacing material. Some has been so used with calcium chloride, but substitution of clay for calcium chloride would be cheaper.

Washed chats are also used extensively as intermediate aggregate in concrete. They are hard and tough, which increases the wearing qualities of such concrete pavement, and the angularity of the fragments increases its stability and flexural strength. Hollow building blocks, sewer tile, and other forms of precast concrete use considerable quantities of washed chats.

In bituminous mixtures for low-cost roads, these chats have found a wide use, for both hot plant-mixed and mixed-in-place material. The superiority of the angular chat particles over round gravel for stability of a pavement is reported to be even more evident in a bituminous mix than in cement concrete. When used in a bituminous mix, gravel tends to roll under traffic and permits ruts to form much more quickly than is the case with chats or other types of crushed rock.

Screened Chats—These contain a lower percentage of fines than washed chats, as shown in Table IV. They weigh approximately 83 lb. to the cubic foot. They are used in place of washed chats where less fines are required, being much cleaner and more closely sized than washed chats. Many lumber dealers and supply houses stock screened chats as an intermediate aggregate for concrete.

Paving Sand — This has been washed and screened and is used in place of river sand in concrete work of all kinds. An average screen analysis is shown in Table V. This sand weighs approximately 87 lb. to the cubic foot. It is clean, hard, and angular, and is used extensively in concrete. Competitive materials confine its use to an area of small radius outside the Tri-State district. See also Table VI.

Blow Sand—Blow sand is one of the special-purpose products made from chats. It is used extensively as a dash on stucco work, being applied with an air gun. It is a clean, angular product which does not discolor in weather through oxidation. Its source must be carefully selected, so that only small quantities of any metallic minerals will be present, especially marcasite. Its screen analysis shows a straight line gradation from coarse to fine. See Table VII.

Blasting Sand—Blasting sand is a uniformly, closely sized product extensively used for such purposes as

Table II—Typical Screen Analysis of "Bank-Run" Chat

Size	Percentage
Minus ½-in. mesh	100
Plus ⅜-in. mesh	9
Plus 4 mesh	48
Plus 8 mesh	69
Plus 14 mesh	81
Plus 28 mesh	88
Plus 48 mesh	92
Plus 100 mesh	95

Table III — Approximate Screen Analysis of Washed Chat

Size	Percentage	
Plus ½-in. mesh	00.8	
Plus ⅜-in. mesh	10.0	10
Plus 4 mesh	53.0	48
Plus 8 mesh	73.0	80
Plus 14 mesh	84.0	96
Plus 28 mesh	92.0	98
Plus 48 mesh	99.0	100
Plus 100 mesh	100.0	100

Table IV—Typical Screen Analysis of Screened Chat

Size	Percentage
Plus ½-in. mesh	00.8
Plus ⅜-in. mesh	14.0
Plus 4 mesh	68.0
Plus 8 mesh	96.0
Plus 14 mesh	99.0

Table V—Typical Screen Analysis of Paving Sand

Size	Percentage
Minus ⅜-in. mesh	100
Plus 8 mesh	2
Plus 14 mesh	19
Plus 28 mesh	40
Plus 48 mesh	80
Plus 100 mesh	90

Table VI—Specification for Paving Sand

Size	Percentage
Plus ½-in. mean	100
Plus 4 mesh	91-85
Plus 10 mesh	72.5-67.6
Plus 40 mesh	61.5-51.4
Plus 80 mesh	40-29.8
Plus 200 mesh	17.5- 7.2

Table VII—Typical Screen Analysis of Blow Sand

Size	Percentage
Minus ⅜-in. mesh	100
Plus 4 mesh	1
Plus 8 mesh	23
Plus 14 mesh	48
Plus 28 mesh	61
Plus 48 mesh	80
Plus 100 mesh	93
Passing 100 mesh	7

Table VIII—Typical Screen Analysis of Blasting Sand

Size	Percentage
Minus 8 mesh	100
Plus 14 mesh	40.20
Plus 20 mesh	72.20
Plus 35 mesh	95.10
Plus 65 mesh	99.20
Plus 100 mesh	99.70
Passing 100 mesh	0.30

Table IX—Typical Screen Analysis of Sawing Sand

Size	Percentage
Minus 8 mesh	100
Plus 14 mesh	2.70
Plus 20 mesh	25.70
Plus 35 mesh	73.00
Plus 65 mesh	97.30
Plus 100 mesh	99.30
Passing 100 mesh	0.70

cleaning boiler flues and sheets, castings, and for removing old paint. Its uniform hardness and angularity of grain make it a superior product and allow it to compete over a larger area than do many of the other products discussed herein. See Table VIII.

Sawing Sand—Despite severe competition from other materials, dimension stone is still used extensively, especially on public buildings. The blocks are sawed to shape by means of a hard, sharp, angular sand. Sand from Tri-State chats is ideal for this purpose, and much of it is used in the quarries around Bedford, Ind., and Carthage, Mo. It must be closely sized. See Table IX.

Rock Dust—Rock dust is usually obtained from the slime ponds, which are the waste product from flotation mills. Most of this material is minus 65 mesh, with a large percentage around 200 mesh.

It is used extensively in bituminous mixes, for absorbing and holding oils, and as a filler to close the voids and improve the density. Its high absorptive qualities make it ideal for use in blotting oils around filling stations. When the bleeding is not excessive, rock dust is often used to blot up excess oil during warm weather on oil-mat roads.

Other Uses of Chat Products—Minor uses to which chat products are put or to which they can be put include filler for composition roofing, gravel for "tar-and-gravel" roofing, bedding in cattle cars, engine sand, and sand for spreading on icy streets and highways. New uses are constantly being sought, and it is expected that research work will reveal many possibilities.

At this point it may be pertinent to state that specifications for highway materials are becoming more stringent, and, in consequence, the companies supplying them are forced to use more care in processing them. The materials that have been described here can be processed to meet such specifications, but to do this will require close technical control of the processing plants.

An example of some of the stringent specifications that have to be met is shown in the following screen analysis required of some material recently supplied to the Arkansas Highway Department. The material passing 200 mesh had to be held within a 2 per cent limit; that is, if the amount of minus-200-mesh material in the first carload was 8 per cent, the rest of the order had to be held within 7 to 9 per cent.

Rock-product or chat-processing plants are usually rather crude, because it has been found more economical to erect a washing or screening plant at the pile which is to supply the material, rather than to build a more elaborate plant and bring in the raw material from a distance. The flowsheet of a typical rock-crushing plant is given in Fig. 2.

The washing plants are very simple, consisting essentially of a power scraper,[2] a small transfer hopper, a belt conveyor, and trommel screen with $\frac{1}{8}$-in. round-hole jacket. Wash water is added as a spray near the feed end of the trommel. Short longitudinal baffles are placed inside the trommel to aid in breaking any lumps. This screen removes most of the material which will pass a 14-mesh sieve. If the mill producing the chats is still in operation, it is often possible to launder the tailings directly to the washing plant, thus eliminating the power scraper and transfer hopper.

Screening plants consist essentially of several sets of trommel screens with belt-and-bucket elevators, and, where necessary for the preparation of special products, one or more sets of Cornish-type rolls. For the finer sizes classifiers are sometimes used.

Generally the practice in the industry has been to process the material and load directly into railroad cars and not to stock finished material. This is due to the ready availability of the raw material and to the varying specifications of the consumers.

I wish to acknowledge the cooperation of W. J. Martin, Miami Rock Products Company, Miami, Okla.; J. L. Smith, Baxter Chat Company, Baxter Springs, Kan.; and S. A. Fones, Interurban Chatt Company, Baxter Springs, Kan. These people have furnished most of the data used in preparing this paper.

[2] W. F. Netzeband: "Surface Transport of Ore & Tailings in the Tri-State District." *E. & M. J.* Vol. 136, No. 12, Dec. 1935, pp. 601–606.

Mechanical Loading Underground

(*Continued from page 243*)

ducing non-ferrous and precious metals. Nearly every district of major importance has installed at least some units of scraper or shovel equipment. No attempt is made to indicate the relative number of units, and hence the Southeast Missouri lead district, now 100 per cent mechanized, is not much more conspicuous on the map than the Tri-State area, in which the number of installations has been small.[13] These two districts, lying side by side, illustrate how largely the factors of size of operation and character of deposit affect the utilization of machinery. In the Tri-State area, the less regular character of the mineralization and of the underground workings, smaller holdings, prevalence of the leasing system, use of small "cans" instead of large-capacity cars in haulage, and other factors have worked to favor hand loading. Nevertheless, adaptation of power loading to the conditions of this district also would appear to be largely a matter of time.

A conspicuous feature of the map is the large number of localities in which loading machinery has been used in the metal-mining districts of the West. Every important metal is represented in the list: gold and silver, copper, lead and zinc, bauxite, manganese, vanadium and molybdenum. Both scrapers and shovels are widely represented, and there are signs of healthy rivalry between the two both for mucking stopes and for development work.

The predominant consideration underlying the introduction of machines is one of cost. In some areas the item of cost alone is now reinforced by the increasing temperatures attendant upon depth. Magma, Bisbee, and some of the hotter workings at Butte are among examples that might be cited of mines where the rock temperatures now encountered make the arduous labor of hand-shoveling increasingly difficult or impossible.

3. That the installation of loading equipment in non-metallic mineral mines has been largely concentrated in the Mississippi Valley and the East. Types of equipment chiefly used consist of power shovels or smaller mobile loaders, though scrapers also are widely distributed. The industries making greatest use of such equipment are those mining limestone and rock salt underground.[14] The metal miner is not always aware that the production of limestone underground has grown from 1,670,000 tons in 1912 to 11,100,000 tons in the active year 1929. Some of this production is obtained from steeply pitching beds by shrinkage methods,[15] but the greater part is loaded underground with power shovels. Loading machinery has also been used, sometimes experimentally, in the underground mining of fireclay,[16] silica rock, glass sand, building sand, gypsum, phosphate rock,[17] ocher, pyrites, fluorspar, and diatomaceous silica rock. Its most recent application is in the mining of potash in the newly developing industry at Carlsbad, N. M., where 98 per cent of the production is produced with loading machines and scrapers.[18]

[13] Carl N. Anderson: "Mining Methods and Costs at the Interstate Zinc and Lead Company's Hartley Mine, Tri-State District." U. S. Bureau of Mines, I. C. 6656, 1932, p. 8.

[14] E. F. La Vigne: "Mining and Preparation of Rock Salt at the Retsof Mine." A.I.M.E., Tech. Pub. No. 661, p. 12.

[15] J. R. Thoenen: "Underground Limestone Mining." U. S. Bureau of Mines, Bulletin 262, p. 69.

[16] "Brick and Clay Record," Oct. 23, 1928, p. 577.

[17] *E.&M.J.*, 1930, Vol. 129, pp. 195-196.

[18] H. I. Smith and R. V. Ageton: "Mechanization of the Potash Mines in New Mexico," *Mechanical Engineering*, July, 1936, pp. 418-422.

American Zinc Institute Discusses Problems at St. Louis

Informative program attracts many from all branches of Industry

REFLECTING the optimistic attitude held a year ago, members of the American Zinc Institute convened in St. Louis on April 26 and 27 for their nineteenth annual meeting, conducted jointly with the Galvanizers Committee. A welcome was given by mayor B. F. Dickman, who referred to St. Louis as the Zinc Center of the world; and therefore a fitting place for the industry to meet and discuss its problems. Charles T. Orr, president of the Athletic Mining & Smelting Company, responded in an inspiring manner, urging continued cooperation among the three divisions of the industry. A report on the work of the Institute was made by Secretary Ernest V. Gent, who described the promotional objectives undertaken and the results obtained.

A competitive demonstration of educational methods to enlighten the farming communities on the use of galvanized sheet was given by two groups of young men, one from Minnesota and the other from Iowa. The financial report of the Institute was made by Treasurer J. A. Caselton, vice-president of the St. Louis Smelting & Refining Company. The possibility of higher freight rates affecting producers of zinc was mentioned in the report of the traffic committee by Homer S. Snow, vice-president American Zinc, Lead & Smelting Company.

Howard I. Young, president of the Zinc Institute, presided at the opening meeting. Events in the world zinc industry and particularly the effects on the domestic zinc markets during the first three months of 1937 prompted President Young to urge continued cooperation in good times as well as bad. A portion of his talk, in view of recent developments in world metal market, is of interest. He said:

"In the last three months we have had a new problem that has confronted us that is one of those nuts hard to crack. We have seen, no doubt, the most rapid advance in the price of non-ferrous metals that has been experienced in the industry during the lifetime of any of us who are present here today except during the War period. Those advances have been more rapid, I believe, than any of us appreciate unless we put some figures before us. When you stop to think that on Jan. 1 the price of metal in London was £18 and it went to a high of £37 before the end of March you can see the advance in the London market was over 100 per cent. At the same time the advance in this country went from 5.45c. to 7.50c., which in round figures is 40 per cent. At the same time, we had in this country fortunately a rapid increase in the consumption of metal. The price structure that has been built abroad cannot be held up, and it will go to whatever the right level is to bring out the proper amount of zinc that is needed by the European countries. I think the industry here has shown good judgment in not following the London market as it had been doing during the years of depression to the full extent that it could have been followed during the months of February and March."

Zinc Outlook

The afternoon session was presided over by Arthur E. Bendelari, president of Eagle Picher Lead Company. Directors for a term of three years were reelected, they being Arthur E. Bendelari, James A. Caselton, C. Merrill Chapin, Jr., Frank Childress, E. Gebhardt, G. A. McCorkle, D. C. Muir, Jr., Charles T. Orr, William T Smith, and F. W. Willard. A paper entitled "The Outlook for Zinc," by W. R. Ingalls, director of the American Bureau of Metal Statistics, was read by Evan Just, secretary of the Tri-State Zinc Ore Producers Association. It was pointed out that a price level around £21 to £23, or about 6c. per pound, and perhaps lower, will bring out all the zinc needed. The outlook, with demand tending to increase, continues optimistic. This ever-growing demand for zinc must be met by domestic producers whose reserves are diminishing, whereas foreign zinc deposits are greater and will be produced at a lower cost.

Pending and proposed subjects of national legislation that may influence any of the phases of the zinc industry dealing with labor problems, new tax laws and silicosis problems were explained and discussed by Julian D. Conover, secretary of the American Mining Congress. J. F. Frogett, Senior Editor of *Daily Metal Trade*, presented a paper entitled "The Zinc Market."

Galvanizing Industry

A well-balanced program for the members of the industry was given Tuesday, dealing with the fabrication of zinc products and how the industry can best serve the farmer, its largest customer. Clarence Glass, vice-president of Anaconda Copper Mining Company, presiding at the afternoon session, introduced U. C. Tainton, who described his comparatively new method of electrolytic zinc practice applied to galvanizing used since 1933 at the Sparrows Point plant of the Bethlehem Steel Corporation in Maryland. A similar unit of large capacity was built at the Johnstown plant of the Bethlehem Steel Company in 1935.

Carl L. Cue, of United Cooperatives, gave members an intimate background of the average farmer's requirements for rehabilitating his barns and sheds. Another method employing zinc for protective coating which is rapidly gaining prominence is metallizing or spraying zinc. This was described by William C. Reid, Mid-Western manager for the Metallizing Engineering Company. Observing the numerous charts and graphs exhibited by the Institute and talks by speakers on the rising consumption of zinc, there is little doubt that zinc is no longer the forgotten metal. Members could not help being reminded of Mr. Ingalls' remarks of our decreasing zinc ore reserves. Charles R. Kimball, of Curtis Publishing Company, presented statistics showing that the farmer is in the market for new equipment and galvanized products should have an important share in this buying.

Wednesday's program was devoted to the Galvanizers Committee, with Nelson E. Cook, general superintendent of galvanizing of the Wheeling Steel Corporation, in the chair. A paper on "Fluxes" was presented by A. T. Baldwin, chemical engineer of the Hanson-Van Winkle-Munning Company. J. A. Succop, chief of research for the Heppenstall Company, and Walter G. Trench, of the Monsanto Chemical Company, St. Louis, discussed "Inhibitors."

The institute reelected the following officers: Howard I. Young, president of American Zinc & Lead Company, as president; vice-presidents, C. Merrill Chapin, Jr., vice-president St. Joseph Lead Company; John A. Robinson, vice-president, Commerce Mining & Royalty Company, and James O. Elton, manager International Smelting Company. James A. Caselton, vice-president, St. Louis Smelting & Refining Company, was elected treasurer and Ernest V. Gent, secretary.

Newly completed 300-ton all-sliming cyanide mill and older 250-ton flotation mill of Weepah-Nevada Mining Company at Weepah, Esmeralda County, Nevada. Ore is mined by power shovel from open cut in draw at right of crusher plant, delivered to coarse bin by 5-ton trucks, elevated to fine-ore bin, and thence sent to ball mill. Cyanidation has replaced flotation and is yielding satisfactory economic results

Nevada

Wage Increases Announced By Most Operators

Commonwealth Mine to have flotation plant—Brucite shipments continue from northeast of Luning—Bentonite under development near Schurz

▶ With the reopening of the snow-blocked mountain road, shipments of brucite are again being trucked to rail at Luning from a deposit 30 miles northeast of that point and reported to be the largest known in this country. Two to three carloads per day of the crude product are shipped to the Basic Dolomite Company at Narlo, Ohio. N. E. Hansen is manager.

▶ A deposit of white bentonite is being developed on the Hicks claims, near Schurz, formerly worked as a gold property. The claims are owned by J. H. Hicks, George Hill, and William Raines.

▶ Equipment for a flotation mill is being assembled at the old Commonwealth lead-zinc-silver mine, in the Galena district, 14 miles south of Reno. Included in the property are nine claims acquired lately under option by L. R. Whitson and J. H. Somers, who are forming a company to work the property. The Commonwealth for some time was under option to the Treadwell-Yukon Company, Ltd. The ore is basic, heavy with iron. Tests have indicated difficulties in concentration.

▶ From its Tybo lead-zinc mine and 300-ton selective flotation mill in Nye County, the Treadwell Yukon Company, Ltd., produced in 1936, prior to the temporary shutdown in November, 7,757 tons of lead concentrate and 3,476 tons of zinc concentrate, with net operating profit of $217,104.47 before the depreciation and depletion. New work on deeper levels failed to find expected continuation of ore to the west below the 700-ft. level, and the Blackburn shoot at the east shows diminution in volume and grade. Future life of the property is expected to be brief.

▶ Development of a large group of copper claims adjoining the Mountain City mine, in northern Elko County, an Anaconda subsidiary, has been undertaken by the Rio Grande Copper Company. Equipment including a compressor, drills, and accessories has been delievered and a 100-ft. shaft has been sunk. Offices are maintained at Mountain City.

▶ In Humboldt County the Valmy silver-lead mine, long idle and lately acquired under option by James D. McPherson, engineer, of Lovelock, Nev., was inspected recently by Herbert C. Hoover, in company with Mr. McPherson. The property has made a small production.

▶ Nearly all operating companies in Nevada have announced wage increases ranging from 25 to 60c. per working shift. First to take this action was the Nevada Consolidated Copper Company, in the Ely district. Others are Mountain City Copper Company, Consolidated Coppermines Company, and precious metals producers at Goldfield, Manhattan, Silver Peak, and other districts.

▶ A substantial volume of gold and gold-silver ore is being shipped to Utah smelters, chiefly by lessees, from properties of the Copper Canyon Mining Company in Copper Canyon and Copper Basin, south of Battle Mountain, in Lander County. These properties produced high-grade copper ore during the War, and the principal gold veins have been developed since that time. R. C. McCarthy is manager, with headquarters at Battle Mountain, Nev.

▶ Ore of high grade, containing gold, silver, and lead, has been exposed at a depth of 175 ft. in a new shaft on the Quo Vadis mine, of the Boulder Canyon Gold Mining Company in the Black Range, Clark County, south of Las Vegas. The mine has produced some rich gold ore.

California

Barium Reduction Plant Going Up in Kern County

Will treat ores from Nine-Mile Canyon—Peckham Hill Gold to resume placer work—Golden Gate mine near Sonora is now under development

▶ Western Barium Corporation is building an initial $75,000 unit of a barium reduction plant at Rosamond, in Kern County, according to R. A. Fredricks, president. It owns extensive deposits in Nine Mile Canyon, near Linnie. Ore is to be trucked to the plant. The company's offices are in the Russ Building, San Francisco.

▶ Coast Range Mining Corporation has leased the Grigsby mining claims in the foothills near Calistoga, Napa County, and next to the Palisade company's mine, now operated by the corporation. L. R. Hare is manager.

▶ Production of 130 tons of ore daily is being made by Virgilia Mining Corporation, at Virgilia, Plumas County. Activity is centered chiefly in developing the Duncan-Hallsted group of claims. A large reserve of milling ore is available. C. H. Potter is superintendent.

▶ Following a two-year program of intensive development work, the Mother Lode Central Mines, Inc., under the supervision of Frank Macpherson, superintendent, has awarded a contract for a 100-ton flotation plant to Mine & Smelter

Supply Company, through the company's California representatives, the Mines Engineering & Equipment Company. Construction will start immediately on the property in Albany Flat, 1½ miles south of Angels Camp, on the Mother Lode Highway.

▶ Mining is to be resumed at the Elgin quicksilver mine, in Colusa County, where a concentrator using flotation is being built. N. C. Stines and J. J. Scott, of Sacramento, are the operators.

▶ Peckham Hill Gold Mines, Inc., will resume gravel placer operations immediately in the Peckham Hill district. The main drainage-transportation tunnel has been extended 2,600 ft., and raising to overlying gravel channels is under way. C. L. Rowe is superintendent.

▶ Hydraulic mining is under way with two monitors at the Lost Camp mine, near Blue Canyon, Placer County. The company maintains its own débris dams on Blue Canyon Creek. J. O. Ziegler is general manager.

▶ A long-term lease on the Golden Gate mine, near Sonora, was obtained recently by Gold Shares, Inc., C. N. Miller, president. The mine is to be put in condition and development started. Brooks M. Dudley is general manager and Curtis Lindley consulting engineer.

▶ The Golden Queen Mining Company has purchased extensive holdings from the Soledad Extension Syndicate on Soledad Hill, near Mojave, including 600 acres of adjoining land obtained by the syndicate from the Southern Pacific Land Company, for a consideration said to exceed $1,000,000. Soledad Extension is headed by Senator Key Pittman, Walter Trent, James E. Babcock, and others, and since acquisition of the property has done considerable development work on claims adjoining the Golden Queen mine.

Arizona

Phelps Dodge Starts Large Expansion Program

Huge low-grade deposit near Morenci to be exploited and 20,000-ton daily production scheduled for company's New Cornelia branch at Ajo.

▶ Phelps Dodge Corporation plans to sell $20,285,000 of convertible debentures to finance the equipping and bringing into production of a low-grade copper deposit near Morenci known as the Clay orebody. It is a very large deposit proved by drilling and exploration, having wide dissemination in granite and quartzite. The company has formulated a five-year program of capital expenditure amounting to $28,000,000 for various purposes besides developing the Clay orebody, such as enlargement of the present plant at Ajo to treat 20,000 tons ore daily; to increase some mine operating programs; and the enlargement of copper fabricating facilities of the company.

▶ The furnaces of the American Smelting & Refining Company at Hayden have been started. Much repair work is to be done.

▶ The M. A. Hanna Company, of Cleveland, Ohio, which has been examining a large manganese deposit in southern Mojave County near Artillery peak for the past seven months, is using two diamond drills. Development to date is encouraging. The Hanna company controls the large groups of claims owned by the Chapin Exploration Company and the Arizona Manganese Corporation. Exploration work is in charge of Benjamin N. Webber, geologist of Phoenix, who makes his headquarters at Congress Junction.

▶ Development of the Hillside group of gold claims near Prescott, in the Copper Basin region, has been begun by George Hopper, backed by Holt Lindsay, of the RKO studios, of Hollywood, Cal. A 4½-in. streak is reported to have run high in gold. The vein averages 2 ft. in width. A mile of road is to be built and machinery hauled in.

▶ The Bell mine, operated by the Mammoth Mines, Inc., is shipping two and three cars of high-grade ore per month to the El Paso smelter, while awaiting completion of a mill on the Santa Maria River near Yava. The work is being directed by E. A. Colburn, Jr., of Wickenburg, president.

▶ American Smelting & Refining Company is employing 25 men at its Swansea mine, near Bouse. The flotation mill is now handling 300 tons daily. The concentrates will be shipped to the smelter at Hayden. E. C. Lane is general superintendent and Bruce Matthews is in charge of the mill.

▶ Mammoth St. Anthony and the Molybdenum Corporation of America have opened a small smelter at Mammoth to handle the concentrates from their 300-ton mill.

▶ The Golden Star Mine, 6 miles from Wenden, is being developed by a California syndicate headed by Allan Sedgewick. It is owned by W. E. Mattson, of Wenden, and had been previously operated by R. R. McDonald, who made several carload shipments. A 700-ft. crosscut tunnel has been run to tap the vein at depth, and drifting is now under way to determine the extent of the ore. The syndicate has also taken an option on the Golden Eagle, adjoining the Harqua Hala south of Salome.

Headframe of the Ruby mine and 400-ton mill of the Eagle-Picher Mining & Smelting Company at Ruby, Arizona. This property is the largest producer of lead and zinc in Arizona

▶ The new 300-ton mill of the United States Smelting, Refining & Mining Company at Gold Road, near Oatman, is now running steadily. W. C. Sayer was recently transferred from Bingham Canyon, Utah, to direct the mill operations. L. H. Duriez, of Oatman, is resident manager.

▶ Tennessee-Schuylkill, at Chloride, is treating 175 tons of lead-zinc ore daily and making an excellent separation of the metals. The company has about 120 men. Jacob Schoder is manager and R. L. D'Arcy mine superintendent.

▶ General Ore Reduction, at Chloride, is running its 70-ton custom mill at full capacity. Many small shipments of ore are being received.

▶ Boriana Mining Company, at Yucca, has about 75 men working in the mine and mill. Tungsten concentrates are being shipped steadily. Extensive exploration is under way on a body of newly found ore. D. B. Rankin, assistant manager, is in charge of the mine work. F. R. Brown is mill superintendent.

▶ A Marcy ball mill has been installed by the Bunker Hill-Arizona on its Sombrero-Butte property. This will increase the tonnage of the selective flotation plant. John H. Pearce is in charge of operations.

▶ Tombstone Mining, which is operating the Gallagher mill, at Tombstone, is treating 45 tons daily, employing about 18 men. At present the ore is coming from the Tombstone Extension dump. Harry Hasselgren is in charge.

▶ Gold Canyon Mining Company, at Patagonia, is shipping silver-lead ore from the old Trench mine and employing 45 men. M. B. Lovelace is manager.

Colorado

Cripple Creek Operators Are Active

Extension of Roosevelt Tunnel planned from Vindicator's 2,000-ft. level—Golden Cycle handles larger tonnage in 1936—Cripple Creek mill treats 90,000 tons

▶ International Gold Producers Company, operating the John A. Logan mine of the Stratton Estate, is producing 70 tons of ore daily from the fifth and eighth levels and is shipping to the Golden Cycle mill at Colorado Springs.

▶ Smith, Siney, and Denny have just opened a 1-ft. vein of good ore on the side lines of the Wacu Weta claim, on the southwest slope of Bull Cliffs, in the Cripple Creek district. They are driving east on the Maud Helena claim, where they have cut ore, which will be worked by shrinkage stoping. They are also drifting west on the Delmonico on the Klondike vein to cut the Pauper vein. More work is under way on Bull Hill than for years.

▶ Hoy and Todd, principal owners of the Cameron Mines, have taken leases on the lower levels of the Vindicator, Deadwood, Isabella, Findley Shurtloff, and other mines and are preparing to drive from the 2,000-ft. level of the Vindicator in continuation of the Roosevelt Tunnel, to cut all of the properties mentioned at the depth of the tunnel which is at an altitude of 8,086 ft. The collar of the Isabella-Lee shaft is 10,460 ft. above sea level. The tunnel is to be 8 x 6 ft. in the clear and will be supervised by Hereford Peiffer, superintendent for the Cameron company. The work will require nearly two years and will cost $250,000.

▶ A 3-ft. vein of ore in the Mary Nevin mine has been followed for 12 ft. on the 400-ft. level. This mine is farther southwest than any other mine in the Cripple Creek district.

▶ After several weeks' shutdown the Kavanaugh mill has resumed treating its own production of oxide ores from the Magna Charta claim. It handles no custom ore.

▶ At the Golden Cycle mill, Colorado Springs, 542,049 tons of ore was handled during 1936, compared to 502,142 tons in 1935. In addition, some 90,000 tons was treated by the Cripple Creek Milling Company, the ore being slightly lower in value last year than in 1935. Total earnings for January and February, 1937, were about $15,000 higher than for the same period last year. Operations at the Cresson mine also showed an upward trend.

▶ Southern Colorado Power Company reports the following new power installations in the Cripple Creek district: A 50-hp. compressor at the Gold Bond; a 75-ft. compressor at the school section; a 150-ft. motor at the Elkton, replacing a 112-hp. motor; a 200-hp. hoist motor at Blue Bird, replacing a 150-hp. motor; a new 250-hp. motor-compressor to be installed at Ajax; a 80-hp. hoist and a 75-hp. compressor to be installed at Nichol. Several of the smaller properties are to install 15-hp. motors.

▶ St. Joe Mining & Milling Company, at Boulder, Colo., is milling about 150 tons of ore from leasers daily. This mill is new and is on the outskirts of Boulder. It handles mostly custom ore. A. A. Zangari is president and R. L. Foote, superintendent.

▶ The Gold Belt Group, above Silver Plume, has been active all winter. This property is peculiar in that the pockets of gold ore which occur provide a continuous belt of gold-bearing ground extending into the east Argentine.

TO MAKE MORE ELECTROLYTIC ZINC

SULLIVAN Mining Company, owned jointly by the Hecla Mining Company and the Bunker Hill & Sullivan Mining and Concentrating Company, has authorized an additional unit for the electrolytic zinc plant at Kellogg, Idaho, which will increase the total capacity by 50 per cent. Work will start at once and will call for spending more than $1,000,000. Last year the plant produced 21,233 tons of zinc and 180 tons of cadmium.

▶ The Old Town mine, in Russel Gulch, is becoming active. It is managed by George Kimbrall.

▶ Increased operations of Minnesota Mines, Inc., at Empire, Colo., will result in greater production of ore. The addition to the mill will soon be complete. D. A. O'Dell is general manager. The Capital Prize Mining Company has much work to do before opening up.

▶ McCraken and Butler, of Victor, are equipping the Pueblo claim of the Acacia company with an electric hoist. This adjoins the Deadwood mine, once a rich producer.

▶ Deepening of the main shaft of the Ajax property will soon be completed. Leasers on the old Gold Coin ground are cutting a crosscut on the fifth level to cut the upward extension of the oreshoot on the seventh level, where they have found some good ore.

▶ S. J. Gately & Associates will deepen the A.P. shaft 100 ft. Ore exposed at the 60-ft. level is being shipped. New mine buildings and a headframe will be erected, and a new gasoline hoist and compressor installed. This group already controls the adjoining acreage, the most northerly property in the district.

▶ Gamble Gulch Mining Company plans to reopen its property near Rollinsville, in Gilpin County, which has been shut down since September, 1933, according to H. C. Koch, vice-president. G. P. Good is manager.

Idaho

Million Ounces Monthly Sunshine Silver's Goal

Bunker Hill resumes sinking at the Crescent Mine—Lucky Boy reported to have cut good ore on Big Creek

▶ Sunshine Mining Company, the nation's premier silver producer, has set a goal of 1,000,000 oz. of silver monthly as the desired production for the current year. R. M. Hardy, of Yakima, Wash., president, stated that production in the first quarter was 79 per cent greater than in the same period last year. Net profits for the quarter were 95c. per share. The company is being sued in the Federal court at Boise for $1,000,000 by the Coeur d'Alene Big Creek Mining Company, for alleged trespass upon its surface and underground property.

▶ Shaft sinking at the Bunker Hill's Crescent mine, in the silver belt of the Big Creek district, has been resumed, following installation of equipment for servicing the shaft to 3,000 ft. During 1936 the Crescent mine produced 682,387 oz. of silver, 194,816 lb. of copper, and 193,439 lb. of lead, with an operating profit, before depletion, of $356,242.

▶ Deep operations in the property of the Sunshine Consolidated, adjoining the Sunshine mine on the west, are progressing steadily. Work is being carried on from the 1,700 level of the Sunshine shaft.

▶ Best Chance Gold Mines Corporation, of Wallace and Lewiston, Idaho, has purchased the Old Colonel Sellers & Mineral Zone property at Elk City. The mine will be reopened and a 50-ton mill built.

▶ Boy Mines Corporation, on Big Creek east of Kellogg, is said to have cut the vein with its crosscut, revealing ore carrying 75 oz. of silver per ton. Henry Giguere, of Kellogg, is president and manager.

▶ Silver Star-Queens mine, one of the early-day producers of the Wood River district, near Hailey, may soon resume production after years of idleness, according to Stewart Campbell, mining engineer. W. J. Stratton, of Spokane, is president of the corporation. The mine produced more than $2,000,000 in silver-lead ore upward of 50 years ago.

▶ Delaware Mines Corporation has sold its property, comprising six patented and 52 unpatented claims in the Beaver district, to James A. Allen, of Spokane, for $75,000. The property has more than 20,000 ft. of underground workings.

▶ Ore from the Liberal King, on Pine Creek west of Kellogg, is being hauled to the Bunker Hill Sweeney mill for custom treatment and testing. The company is planning to erect its own mill soon. New machinery is being installed at the mine.

NEWS FROM Washington

By Special Correspondent

ANNOUNCING a $26,000,000 construction program, which starts with a big new plant at LaFayette, Ind., the management of Aluminum Company of America promises price control. It "is sympathetic with the efforts to restrain advances in the prices of durable and consumer goods, and the policy of the Company for the remainder of 1937 will be to maintain present prices and make advances only if necessary to meet increased costs of labor and raw materials."

There is no official admission that by this means aluminum hopes to gain more of the competitive market away from copper and brass, but undoubtedly this is a substantial factor back of the self-restraint indicated. As one Washington commentator said during an earlier spasm of high price competition, "The metal which goes up the most has to come down the farthest later." In April 20c. aluminum has been meeting in competitive areas approximately 16c. copper, in sharp contrast with the relationships a few months ago when 18c. and 9c. were prevailing quotations.

The new plant to fabricate and extrude shapes, tubing, and related products will supplement other present locations. Reduction plants which make primary pig aluminum from the alumina prepared at East St. Louis from bauxite ore will continue operations at Massena, N. Y.; Alcoa, Tenn.; and Badin, N. C. Other fabricating operations of the company, at New Kensington, Pa., for example, will also continue. But none of these old locations was as satisfactory for the new development as the centrally located site chosen.

Important in choice of the new plant site were state and local policies, encouraging well-financed new industry, and the available skilled dependable labor. Very cheap power, essential for reduction plants, although important for extruding and fabrication, is decidedly secondary in its cost significance to tax, employment, and other operating factors. Pig metal can be brought to Indiana for the new processing division and then the finished products most economically distributed in the higher unit-value forms from this central point to the major customer markets.

Minerals for Navy

SPENDING for the Navy next year will be generous, insuring big demand for many of the mineral products and metals required in shipbuilding. But plenty of problems remain before actual sales will be accomplished.

Assistant Secretary Edison admits that the copper and the steel problems have been "solved." But the adequacy of supplies of manganese, chromium, tin, and certain non-mineral commodities provide plenty of headaches. Members of the House wanted the Navy to build up rapidly a reserve stock of strategic war materials and provide a $5,000,000 special allotment for next year to start stockpile building. (See *E.&M.J. April, p. 206.*)

In conference with Senate officials, who do not like this general idea, the sum was cut to $3,500,000, and the provision eliminated which required that these commodities be built up from supplies of ore originating in the United States. Representative James G. Scrugham, from Nevada, major advocate of this plan, forecasts prompt building up of reserves of manganese, tungsten, chromium, tin, antimony, mercury, and nickel. He does not conceal his disappointment that foreign sources of these metals may be tapped.

The general building program for fighting ships will be supported with funds amounting to approximately $180,000,000, which can be spent during the fiscal year beginning July 1. Access to those funds requires only the jumping of Walsh-Healey Act hurdles.

BUDGET TROUBLES

EXPECTED INCOME from last year's tax bill was not realized by the Treasury. The deficiency in expected income before the first of July, below last winter's budget estimates, is now estimated to be $640,000,000. *Expenditures are greater than expected. The deficit by July 1 for the present fiscal year will, therefore, exceed the President's printed January expectation by about three-quarters of a billion dollars. As a consequence, the Administration faces a deficit of* $3,250,000,000 *at a time when the President said we would be approaching balance. Obviously, the none-too-close approach worries officials.*

FOR NEXT YEAR there is much talk of economies. Heads of departments, bureaus, and independent commissions are told to be careful in their spending. But everyone analyzing the situation can see clearly that the economies which can be so achieved are no more than equal to one month's relief spending. The President, however, cannot (better, probably, will not) face the one workable means of securing real economy.

IT APPEARS politically much better to raise taxes. And the tax-raising operation permits punitive, disciplinary, and reform objectives to be served when the tax gatherer goes out to collect the new revenues. Relief allocations estimated in April are not persuasive as to the full amount that will be spent next year. The desire to appropriate less now does not obscure the fact that well over $2,000,000,000 *will be "given away" next year. Real economy is not in the making.*

What Are "Wages"?

IF A CONTRACT MINER gets special allowances for explosives or other supplies, the value of these is not a part of the wages paid, as this term is used under the Social Security law. The Treasury Department is clarifying this and many other matters affecting compensation on which taxes are levied.

In general, the Treasury is building up a set of rules which say, in effect, that whatever is to the individual benefit of the man must be regarded as compensation, but that which merely helps him do his work, and is in effect an item of his costs, need not be included in calculating wage tax levies. Any provision for housing, special food allowances, or other things which clearly benefit the worker, are part of his compensation.

Washington observers say good practical common sense evidently is going to govern these matters.

Resource Studies

TALK OF PREPAREDNESS, scrap-export limitation, Navy strategic-mineral supply, and other related topics renews official interest in mineral policy studies. Several important proposals have been made. Late in April no officials are willing to announce just what they plan to do in the next fiscal year. This restraint in comment originates largely from the uncertainty as to departmental reorganization, appropriations expected, and the effect of Presidential economy demands.

Despite these limitations, it appears certain that at least one fundamental investigation will be under way in Washington by July 1. It is likely to pick up the projects left by the uncompleted study of the Planning Committee for Mineral Policy. Reestablishment of that committee on its old basis is not expected. Those most concerned say definitely that we must have industrial as well as governmental minds at work on these projects if new committee plans are to be effective.

Among the topics which it appears will be studied under some of the projected plans are the following:

1. Depletion of ore reserves.
2. Effect of taxes on mineral conservation.
3. Export factor in international competition and in preparedness.
4. Building of military reserves of strategic or deficiency minerals.
5. Feasibility of embargo on reserves in order to restrain militaristic governments.
6. The proper legislation in order to give long-time service to the nation as well as to the industries affected.

Washington hears reliable-sounding rumors that the real basis for international

collaboration will be found in agreements between quasi-governmental agencies of Britain and large industrial units of the United States. The hesitancy of the American Government to enter into compacts affecting trade restraint is so great that unofficial negotiations seem probable, and necessary.

Scrap

SCRAP EXPORT is now a very real technical as well as political problem. Although iron and steel thus far have been the cause of most of the controversy, all other scrap metal problems are likely to be dragged into the spotlight before the affair is over.

Fundamental principles of economic mineral relationship are involved. Iron and steel scrap exports are unquestionably affording foreign steel makers a commercial advantage as against American industry. It is so much cheaper to make steel from scrap than from ore that forcing the United States industry back further toward an all-ore basis would be serious. This *commercial* consideration is admittedly more serious than many of the *political* aspects about which Washington worries.

Supplying foreign nations with military reserves of metal has been the prime concern in official circles. No one sees just how the United States is going to be embroiled with the nations that take the scrap, but still there is a natural hesitancy about shipping the huge tonnages which have gone to Japan, Italy, Germany, and the other nations. It is indisputable that with respect to British purchases the main concern seems commercial, not military.

Legislation regarding tin scrap export and the brief experience with its enforcement are not proving helpful in the guidance of Congress or departments as to further legislation. It is difficult late in April to figure what course will be followed. But the trend clearly is toward placing license control over export of many commodities. Iron and steel scrap proposed legislation is but a sample of this trend.

Boulder Power Rates

THE PRICE SCHEDULES for power from Boulder Dam, fixed when that enterprise was authorized, are proving impracticable of present application. Mining and mineral interests of the West are likely to be drawn into the plans of readjustment. This may be beneficial to these enterprises if some of the requisite cuts in power price are agreed to.

Much of the present trouble results from the completion of Boulder Dam many months ahead of schedule. The states and other agencies allocated blocks of the power are not ready to take it. Furthermore, the prices fixed some years ago are now much higher than the economic worth of the power at such locations, an inevitable consequence of New Deal projects planned and effectively developed to force power rates down generally.

Most directly of concern to Western mineral interests is the proposal that some plan of Federal subsidy be arranged for enterprises which will make electrometallurgical products near Boulder Dam, using the Nevada block of power. If such arrangement cannot be developed, that sparsely settled State has no idea what it can do with the energy to which it is entitled. Until the recent economy demands of the President became so insistent, it looked as though the Nevada delegation of Congress might be persuasive in getting subsidy. This prospect looks less certain in late April, but the plan has not been abandoned.

LAWMAKERS AT WORK

LEGISLATION is moving forward steadily, though not fast. Those who have thought that relative quiet in Congressional committee rooms meant no progress were badly deceived. A lot of hearings have been held and legislative plans made which were overlooked in the confusion and clamor over the Supreme Court reorganization. As a matter of fact, in some cases important arrangements for enactment of other legislation have been a part of the private conferences in which the Supreme Court vote of individual members was at stake. Only final enactment is delayed.

AMONG the measures of substantial importance to the mining industry which will come through in due time are, among others: Neutrality legislation, more rigorous Walsh-Healey Act limiting Government contracts; scrap-export regulation, supplemental authority for National Labor Relations Board, stream pollution legislation, and a tax law.

NO ONE who looks carefully at the fiscal situation can for a moment accept as persuasive the enthusiastic, sincerely wishful, and politically hopeful promises from White House or Capital that no new taxes will be levied on this year's business. Enactment may wait until January, but levies will apply to 1937 *enactments, almost certainly.*

More for F.T.C.

EVEN if Federal Trade Commission were given all the authority which various legislative proposals accord it, one could properly dub it the Hitler of Washington. There is no danger of enactment of many, probably most, of the many bills. But there seems to be no doubt that the Commission will have substantially enlarged authority before Congress goes home. (Nobody knows yet when that will be, but it will not be soon.)

Regulation of all kinds of advertising is one of the types of new authority suggested. More important to mineral industries are the proposals that the Commission can issue complaints on its own initiative, and that it may cite companies for deceptive acts and practices without having to prove their effect on competition.

All of these matters are important to every business enterprise, because they represent a constantly growing opinion in Washington that the Federal Government must protect the public in many new phases of business relations. Also, F.T.C. has one of the most influential lobbies in Washington. It would like to have its authority substantially extended. It would even accept, not unwillingly, authority over some extremely difficult regulatory jobs: advertising of foods and drugs, for example. Paternalism is certainly growing in Congress. Its effect on legislation can be expected to show for some time to come. Perhaps F.T.C. is the most favored son of paternalism, but it is by no means the only child which grows lustily.

The mining industry may have to consider within a short time whether compulsory enforcement of trade practice regulations should be encouraged when 40 to 60 per cent of the industry asks for them. That very specific form of so-called "self"-regulation may be pressed seriously soon.

Tailings

REGULATIONS governing the exercise of mineral rights on land conveyed to the United States have been announced by the Secretary of Agriculture. Anyone who wishes to dig a hole, erect a structure, use mine timber, or conduct other mining or prospecting operations, should study the new rules issued recently through the Forest Service and already in effect.

Reappraisal of the damage from smelter operations at Trail, B. C., by the International Tribunal of Canada and the United States, will be facilitated through funds being granted in current appropriation bills. The old controversy continues. The Department of Agriculture supports the farmers, and the Bureau of Mines the mineral industry operations. As referee, the State Department leans, but which way it is hard to say as yet.

New methods for compiling import data undertake to define imports in terms of the country from which they really originated, not merely the point where they embark for final passage to the United States. The following statement from the Treasury decision on this subject makes clear the objective, as well as the technique to be followed:

"The country to which imports shall be credited for statistical purposes is the country of origin. In cases in which the merchandise is invoiced in or exported from a country other than the country of origin, care should be taken to insure that the country of origin is correctly specified. Entries for immediate consumption or for warehouse, and withdrawals from warehouse for consumption, shall clearly specify the country of origin of the imported articles as well as the nationality and motive power of the vessel from which the imported articles were landed in the United States or in Canada or Mexico if shipped through either of these countries."

Three sections of a 1,000-ft. conveyor system for transporting tailings to the No. 3 re-treatment plant of the Cardin Mining & Milling Company near Century, Okla. This mill has a capacity of 100 tons per hour

Tri-State

Eagle-Picher Increases Central Mill Capacity

Buys lease on Robert Lottson tract from Velie Mines—Muncie Mill rebuilt—Commerce rehabilitating Beaver tailings plant

▶ Commerce Mining & Royalty Company is rebuilding its Beaver tailings re-treatment mill on the Anna Beaver lease. The new plant will handle 100 tons per hour and is expected to be ready by May 15. Butchart flotation cells in the company's Bird Dog mill have been replaced with new Minerals-Separation machines. They are now producing about 70 per cent of their concentrates as flotation concentrates. This gives better metallurgical efficiency, as much of the ore is "chatty" and requires fine grinding.

▶ Eagle-Picher Mining and Smelting Company is adding equipment to its Central mill as another step towards the goal of 10,000 tons' capacity in 24 hours. A 7-ft. Symone Short-Head cone crusher is being installed to supplement the present crusher of the same size. Another No. 86 Marcy ball mill will replace two small Cole ball mills. Two more 14-cell Minerals-Separation machines are being added.

▶ Eagle-Picher has bought the lease on 120 acres of the Robert Lottson allotment from Velie Mines Corporation. This includes the Lion and Harrisburg mines. Eagle-Picher already owns the lease on the other 40 acres of this allotment, on which are the Crystal and Central mines.

▶ Pumping in the Oronogo-Webb drainage district has been extended south to Prosperity. Eagle-Picher has moved the 14-in. Pomona turbine pump from No. 6 station at the Good mill shaft and installed it in the Florine shaft, a half-mile west of Prosperity.

▶ Like many other older areas, the Tri-State district is faced with the problem of recovering the remaining ore from nearly depleted mines. Many of these properties have long been inactive and have had the mills removed, or else the mills are in such disrepair that it would take too large an investment to place them in operation and the ore left does not warrant such an investment. This problem has been attacked in two ways: The first has been to use the central and custom mill. The Bird Dog mill represents the former type and the Central mill, of Eagle-Picher, was the first successful example of the latter. A number of custom mills have been put in operation during the past few years. The other method of attack has been to treat crude ore and tailings together. This insures a sufficient tonnage of heads to keep the mill running steadily and tends to "sweeten up" the lean tailings. The usual practice has been to treat 1 ton of crude ore for every 6 tons of tailings.

▶ Federal Mining & Smelting Company has rebuilt the Muncie mill, destroyed by fire on March 6. The new mill will duplicate the one destroyed and will have 50 tons' capacity per hour. The company is also building a mill of 20 tons' hourly capacity near Spring City, Mo.

ANACONDA RAISES WAGES

ANACONDA has advanced its base wage scale in Montana to $6 a day, with equivalent adjustments upon contract assignments. Including all Montana units, approximately 13,000 employees are affected. This compares with $4.25 a day during 1934. The current production rate is approximately 25,000,000 lb. of copper per month, compared to 8,000,000 monthly during 1934.

Arkansas

Zinc-Lead Field Revives With Higher Prices

Rush Creek Camp most productive—Monte Christo Mine is now building 100-ton mill—Lonnie Boy mill to be rebuilt

▶ Higher prices for zinc and lead ore have started operations again in the north Arkansas zinc and lead field. Shipments, though small, are regular. John Dirst has been employed by the M and A Railroad to buy ore along its line. A local market for the ore has given the industry momentum, and each week a few new properties start production.

▶ The Rush Creek camp, embracing an area several miles square, lying adjacent to Rush, Ark., in Marion County, is the most productive. Properties that are operating are producing carbonate of zinc.

▶ Roscoe Hicks and associates, who have the Mackintosh mine, in the Rush Creek camp, under lease, are shipping carbonate ore regularly. They also have approximately 1,500 tons of milling ore in their bin that will run about 15 per cent. Luther Evans and associates have leased the Yellow Rose and are cleaning it up. They are taking out a small tonnage of carbonate ore.

▶ The Urshel Lead & Zinc Company is operating the Silver Hollow, La Rue, and Lonnie Boy zinc mines, in the Rush Creek camp, and a lead property near Ponca City, in Newton County. The Lonnie Boy mill, which burned down recently, is to be replaced.

▶ A 100-ton mill is being built at the Monte Christo mine, in Rush Creek camp, and will probably be ready June 1.

▶ Case Brothers, who have a lease on the Edith mine, in Rush Creek camp, plan to strip the ground by hydraulic means.

Mexico

Base Metal Exports Make New Record

Cusi Mexicana seeks permission to suspend—Dos Estrellas reports loss for year —San Carlos will build flotation plant in Chihuahua

▶ Some progress, with labor troubles pushed a bit in the background, is noted in the mining industry in Mexico as spring advances. Improved markets in general at home and abroad favorably affected production. Restlessness in Europe worked to the advantage of lead, zinc, and iron producers. Record exports of these metals were made to the Old World. On the darker side, Cusi Mexicana has asked permission to quit because of poor showings and Dos Estrellas experienced a bad financial loss, according to its 1936 report.

▶ Contending that explorations have failed to give expected results and that operating losses are mounting, Cusi Mexicana has asked the Federal Labor Board for permission to suspend work at Cusihuiriachic, in Chihuahua.

▶ French interests represented by Jean Polzvolski have contracted with the miners' union for employees to work an antimony concession in the Ejutla and Ocatlan districts, Oaxaca.

▶ Mexico's first cooperative for producing railroad rails is to be organized of railroad workers by the Federal Government. Raw material will come from iron in national mineral reserves. A foundry is to be provided.

▶ A flotation plant is to be built by Cia. Minera de San Carlos at its property, Mineral de San Carlos, in Chihuahua. The company has asked for a Federal franchise to use waters of a near-by brook for power purposes.

▶ War clouds abroad are stimulating exports of iron to several European countries. Upward of 200,000 metric tons of the metal, from Cerro de Mercado, near Durango City, produced by a subsidiary of the Monterrey Iron & Steel Works, went to Europe during the late winter.

▶ Although it obtained 717,755 metric tons of ore averaging 2.47 grams gold and 60 grams silver last year, Cia. Minera Las Dos Estrellas, operating at Tlalpujahua, Mich., and at El Oro, Mexico, reported a loss of 793,476.53 pesos for 1936 at its annual meeting. Experts of the Federal labor board are to inspect the property because of the company's plea that a wage reduction is justified.

▶ Operations of Neg. Min. de San Rafael y Anexas in the Pachuca district are again normal since the signing of a new collective contract with employees which allows increased pay and other benefits. Louis Garbrecht is general manager.

▶ Efforts are being made by the Federal Government to settle a strike for higher wages and other demands which began at the property of the Mexican Candelaria Company, at Contraestaca, Sinaloa, on March 26.

▶ Unwatering is completed at the Democrata mine of Cananea Consolidated Copper at Cananea, Son. Prospecting and development are to be undertaken. The company is to use three sections of its mill for ores from the Duluth and Democrata mines. At present, only one such section is used. About 200 workmen have been reemployed.

Michigan

Isle Royale May Acquire Interest of Calumet & Hecla

Capacity of Champion Stamp Mill increased by Copper Range—Drilling stopped at Ropes Gold Mine in Michigan

▶ Isle Royale Copper Company has elected a new board of directors as follows: F. Ward Paine, Stephen Paine, Frank H. Brown, and James Nowell, all partners in Paine, Webber & Company; Harold C. Schulte, Albert Foots, and B. D. Noetzel, all of Houghton, Mich. The new group thinks of buying for investment the 23.3 per cent interest held by Calumet & Hecla in Isle Royale. Closed for five years, the mine will be reopened. The following officers were elected: President, H. C. Schulte, Houghton; vice-president, Frank H. Brown, Boston; treasurer, F. Ward Paine, Boston; secretary and assistant treasurer, B. D. Noetzel, Houghton. The directors voted to unwater the mine as soon as practicable. It is variously estimated that 20,000,000 to 30,000,000 lb. of copper is available for stoping in Isle Royale once the water is drained. Isle Royale's quick assets as of Dec. 31, 1936, total approximately $300,000 in cash and United States Treasury securities.

▶ Copper Range is increasing the capacity of the Champion stamp mill. Classifier and grinding capacities will be enlarged, to permit larger production. Changes have been made in the electrically operated crushing plant, which has been operating steadily. Because of these improvements, rising costs of labor and supplies have resulted in no material change in total milling costs. Negotiations are under way for the purchase of a 2,000-lb.-per-hour "Lectromelt" electric furnace for the smelter, the primary object being to produce special grades of cake copper for C. G. Hussey & Company, the company's subsidiary, which takes its entire output.

▶ Calumet & Hecla has stopped diamond drilling at its Ropes gold-mine property in the Ishpeming district in Michigan. Its workings are being kept free of water. The company started work more than two years ago and carried on diamond drilling and drifting. The last report shows a million tons of ore averaging about $4.50 a ton in gold and silver. Diamond drilling showed the orebody to extend more than 700 ft. deeper.

Iron Country

Longer State Leases Sought With Higher Royalty

North Range takes up two tracts at Grand Rapids—Charleson Company stripping at Aurora

▶ A bill has been introduced in the Minnesota Senate to extend the State Leases for a period of 25 years, the operators paying a royalty of 40c. instead of the old rate of 25c. This will affect the big Mesabi Mountain mine, at Virginia; the Hill-Annex, at Calumet; the Grant, at Buhl, and several other rather large properties.

▶ Cleveland-Cliffs is planning to install a stacker at the Hill-Trumbull washing plant at Calumet.

▶ Stripping is under way at Aurora, Minn., by the Charleson Mining Company. A new 1¾-cu.yd. Marion diesel-electric shovel has been moved in. It is expected that 200,000 tons of ore will be mined for shipment this season.

▶ North Range Mining Company, active in the Grand Rapids district in exploration work for the last year, has exercised its options on two 80-acre tracts. One of these is the Jordan and the other a State Mineral Contract. R. S. Archibald, of Negaunee, Mich., is president. C. K. Quinn is associated with him.

IRON ORE MOVING DOWN LAKES

SHIPMENTS OF IRON ORE from the Lake Superior ranges are now moving steadily down the Lakes. The underground mines began shipping to the docks at the upper ports early in April and on the 12th of the month various open pits and washing plants followed suit. The first boats to arrive at the docks from the Lower Lake ports were the "Frontenac" and the "Peter White," of the Cleveland-Cliffs Steamship Company, which has a contract for the Republic Steel Corporation. These first cargoes were consigned to the latter at Buffalo and Cleveland respectively.

OPERATORS have made plans for maximum activity and, barring the unforeseen, the 1937 season is expected to be a banner one. No trouble is anticipated from labor, inasmuch as the work on the Mesabi is seasonal and the men would only lose valuable time. Stocks of ore at the furnaces are as low as at any time in the last 25 years.

J. O. ELTON, vice-president International Smelting Co., digs first shovelful of earth in projected 23,000-ft. tunnel

THE SHOVEL AT WORK excavating the approach to the prospective tunnel of the National Tunnel & Mines Company, that will permit deep development of mineral-bearing limestones

Boring Starts at Bingham

Utah Copper and National Tunnel & Mines Begin Work On Their New Projects

YEARS of planning and mining development reached a climax in Utah this month, when two giant tunnel projects were started in the Bingham district. One tunnel is being driven in the Bingham district proper by Utah Copper Company a distance of 7,000 ft. at an estimated cost of $1,000,000 as a vehicular tunnel to connect Copperfield, in the upper part of the camp, with lower Bingham at a point near the junction of Bingham and the South Fork of the canyon.

Contract for driving this tunnel has been awarded by Utah Copper Company to Utah Construction Company. When completed, the highway through the tunnel will be hard-surfaced together with the walls and roof. Adequate lighting, ventilation, and drainage will be installed. Completion of the tunnel will allow transportation and travel to proceed without hindrance to mining operations.

The second tunnel is that of the National Tunnel & Mines Company, recently formed by the merger of Utah Apex and the Utah Delaware companies. This tunnel, costing approximately $700,000, will be nearly 23,000 ft. long. The portal will be a half mile northwest of the Tooele smelter.

Steam shovels are chewing out the 700-ft. open cut to the portal of the tunnel and leveling off the space required for workshops and yard facilities. The contract for this work and building of three miles of railroad to connect the tunnel with the Tooele Valley Railroad has been awarded to Ryberg Brothers, Salt Lake contractors. The 12x12-ft. bore will parallel the present Bingham-Tooele tramway of the International Smelting Company. Grade will be 17 ft. to the mile. The tunnel will pass under the Tooele smelter and connect with the Rood shaft of the Utah Apex mine, in Carr Fork, Bingham, on the 2,500-ft. level. A 300-ft. raise will connect the tunnel and the smelter power house so that blowers can be operated to supply ventilation. From floor to ceiling there will be an overhead space of 9 ft. Three feet of the tunnel will be occupied by a covered water conduit and railroad ballast and the standard-gage railroad track.

Direct outlet to the Tooele smelter will be supplied by the new tunnel for ores from properties of the National Tunnel & Mines Company, controlled by International Smelting. Drainage for Bingham properties will also be provided. From 15 to 20 sec.-ft. of water will be developed for irrigation purposes. Convenient transportation for workers, supplies, and ores will also be made possible. In addition, eight to ten of the most important mineral-bearing limestone beds of the district—the Yampa, the Highland Boy, the Washington, and others—will be opened up for economical prospecting at great depth.

For a number of years, a tunnel into the Bingham district from the Tooele side of the mountain range has been discussed. Over fifteen years ago, the Utah Apex Mining Company bought a quarter of a section of ground near Tooele, the present site of operations, for the purpose of driving the tunnel, but it remained for J. O. Elton, general manager of the International Smelting Company, to consummate all arrangements this winter, and actually dig on March 29 the first shovel of earth, signifying the launching of this project.

About 100 men will be employed in driving the tunnel, a job which, it is said, will take two years to complete. It is probable that the National Tunnel & Mines Company will itself drive the tunnel.

▼

Fellowships in Mining and Metallurgical Research

THE department of mining and metallurgical research of the Utah Engineering Experiment Station, at Salt Lake City, is offering five research fellowships, with stipends of $500 each, for the year 1937-38. The subjects in which research work will be conducted include: 1, Mine ventilation. 2, Ore dressing (find grinding and classification, flotation, etc.). 3, Ore dressing microscopy (mineralogical studies of ores and mill products, problems in paragenesis, etc. Also microscopy of building materials, foundry sands, filter clays, etc.). 4, Flotation fundamentals (physical-chemical investigations of flotation phenomena). 5, Non-ferrous pyrometallurgy and hydrometallurgy (roasting, smelting, leaching, etc.). 6, Thermodynamic properties of compounds of metallurgical importance. 7, Bituminous coal research (studies of ash and volatile matter, coking properties, etc.).

Surface plant of the Cariboo Gold Quartz Mining Company, Ltd., first and largest lode producer in the old Cariboo district. The new town of Wells is 2 miles distant. The capacity of the mill (lower left corner) was recently increased to 225 tons a day

Canada

B. C. Nickel Mines Reports Increased Reserves

Negotiations for sale of concentrates well advanced—Deep lead development at Wingdam progressing—Granby starting mill at Copper Mountain

▶ Negotiations with Japanese interests for the sale of nickel concentrate by B. C. Nickel Mines, Ltd., are well advanced, according to the company's annual report. During the past year operations at the mine, near Choate, in the Hope district, were directed largely to blocking out known orebodies, and resulted in an increase of 140,000 tons in ore reserves, now estimated at 1,183,000 tons, averaging 1.39 per cent nickel and 0.5 per cent copper. Plans for reorganization will be considered at the forthcoming annual meeting whereby the advances of the operating syndicate, amounting to about $1,300,000, would be liquidated by the issue of shares in a new company. It is also proposed that a 250-300 ton mill be built immediately, capable of being enlarged to 500 tons as markets are developed. After much research it has been concluded that the ore should be concentrated by flotation at the property in the ratio of 6 to 1, the concentrate from which would assay about 8 per cent nickel and 2.5 per cent copper and contain important values in gold and platinum. Further reduction by sintering and smelting, which could be done in Canada, would produce an 80 per cent nickel-copper matte, the ratio of concentration being 7 to 1, but this step has not yet been decided upon. It is definitely indicated, however, that the final separation and refining of the metals, presumably because of patent rights, must be done abroad. C. B. North is manager.

▶ Output at Cariboo Gold Quartz had a value of $700,283 in the year ended Dec. 31, according to the annual report. Ore reserves were approximately 209,636 tons, averaging 0.416 oz. gold, and the net increase was 57,048 tons, compared with the previous year's estimate, after allowing for 53,279 tons milled. Rate of production was increased from 200 to 225 tons a day on April 1. Output in March established a new monthly record, 2,639 oz. gold, valued at $92,365, being recovered from 6,444 tons of ore. Wages at the Cariboo Gold Quartz and the Island Mountain, the two largest lode producers in the district, have been increased to $5.25 per 8-hour shift for miners, $4.50 for muckers, and $4 for surface workers.

▶ At Consolidated Gold Alluvials "deep load" operation on Lightning Creek, Wingdam, two small drifts are being advanced upstream and downstream in the gold-bearing gravels of the ancient creek gutter, which was entered in a raise put up from the "wash drive" in February. From these gravels 67 oz. gold was recovered in March, and from the Sanderson workings in the interglacial deposit a further 668 oz., the total value of output being $22,785.

▶ Development work at the former B. C. Silver and Sebakwe properties, Portland Canal district, proceeded satisfactorily during the past year under Silbak Premier Mines, Ltd., according to the annual report of Premier Gold Mining Company, which controls the project. Unbroken ore reserves at the end of 1936 were estimated at 147,006 tons, averaging 0.28 oz. gold and 6.88 oz. silver per ton. Sufficient ore remains in the old Premier to supply the 500-ton mill until May, when mining will begin at the adjoining B. C. Silver and Sebakwe properties.

▶ Operation of the Granby company's 3,000-ton mill at Copper Mountain will be resumed in May, after six years of idleness, according to A. S. Baillie, general manager. A three-year agreement has been made with Japanese interests for the sale of copper concentrate, which will amount to about 4,000 tons a month. The first unit of the company's new 15,000-hp. steam power plant at Princeton is in operation.

▶ Production at the Hedley Mascot, in the Similkameen district, had a value of $713,267 from the start of milling, May 5, 1936, to March 31, 1937. As 43,182 tons was treated, the realization was $16.52 a ton, mostly from gold values. The mill has been enlarged from 150 to 175 tons a day.

▶ Preparations are being made to resume production at a number of old lead-zinc properties in the Slocan, including the Lucky Jim and Whitewater, equipped with a 200-ton and a 150-ton mill respectively. Ottawa Silver has been producing for several months at the rate of 100 tons a day. Western Exploration Company, Ltd., is reopening the Mammoth after the winter shutdown. It is planned to build a 40-ton mill at the Utica this year.

▶ Encouraging results have been obtained at Sheep Creek Gold Mines, near Salmo, where ore has been opened in the Hideaway vein at the seventh level for a length of 112 ft., averaging well over an ounce gold per ton across 5 to 6 ft. Ore carrying from 1 to 2 oz. gold has also been opened in the Bruhn vein for 45 ft., the width averaging about 1 ft.

▶ Satisfactory progress is being made at the other properties in the Sheep Creek camp, including the Reno, the Kootenay Belle, and the Gold Belt.

▶ In the Ymir camp, in the Nelson district, another mill will start this spring, when Dentonia Mines, Ltd., installs a 100-ton plant at the Durango property. This will be moved from the company's old Greenwood property. Gross smelter returns for shipments from Ymir Yankee Girl in February were $34,177, and operating profit was $8,900. Tonnage milled was 2,881. Ymir Consolidated's 100-ton mill was closed early in March, as ore reserves were exhausted. Continuation of exploration was recommended by the engineer.

▶ Construction of a 1,000-ton concentrator is planned for the Reeves-MacDonald mine, south of Trail, just across the boundary from the Pend Oreille Mines & Metals, the parent company. Ore reserves in 1929, when work was suspended, were estimated by the company's engineer at 2,000,000 tons, averaging 0.5 oz. silver, 1.7 per cent lead, and 6.6 per cent zinc.

▶ Development at the Bralorne mine, at Bridge River, now the leading gold producer in British Columbia, was successful last year in increasing the value of ore reserves by almost $2,750,000, to about $8,000,000. Proved and probable ore at the end of 1936 was estimated at 505,000 tons, of an average grade of 0.45 oz. During the year 167,264 tons was milled in the 475-ton plant, averaging 0.4111 oz. gold per ton. Net profit was $751,509 after deducting depreciation, depletion, and taxes.

▶ At the Pioneer, adjoining the Bralorne, bullion worth $185,000 was produced in March. Operating expenses were estimated at $78,000.

Africa

Southern Rhodesia Boosts Gold Mining Tax

Anglo American and British South Africa Company finance Rhodesia Broken Hill—Eldoret Mining Syndicate considers liquidation

▶ Eldoret Mining Syndicate, which formerly held large prospecting areas in the Kakamega district and other parts of Kenya Colony, East Africa, is considering voluntary liquidation. The best of its holdings were sold to Kentan Gold Areas and Kimingini companies. The action now contemplated indicates that further exploration of properties retained has been disappointing. Kimingini has not yet come up to early expectations, but is getting its mine into condition to supply the mill with better ore. Heads averaged 6.11 dwt. in March. Treatment of 3,018 tons yielded 843 oz. of fine gold.

▶ Bushtick, a courageous attempt to make an abandoned low-grade mine in Southern Rhodesia pay, is milling about 12,000 tons of ore a month, recovering about 2.72 dwt. of gold per ton and netting about 6s. per ton after deductions for development, redemption, and government royalty.

▶ Southern Rhodesia is increasing taxation by 9d. in the pound to 3s. 9d. on general incomes, and by 1s. 3d. to 4s. 3d. on gold-mining incomes. This is causing dissatisfaction, and the government plans to submit a bill later to recast mining taxation. Because of the low grade of the ores and their occurrence mostly in narrow veins, the Colony's gold-mining industry needs encouragement.

▶ German interests are said to be negotiating a loan to reopen the properties of the Otavia Mines & Railway Company in West Africa.

▶ Improvement in the price of zinc has enabled Rhodesia Broken Hill to abandon the drastic refinancing plan announced some time ago. A large issue has been underwritten at 5s., less 6d. commission, by Anglo American Corporation and British South Africa Company, which will enable the company to pay off the rest of its debts, develop its deep lead ores, and erect a treatment plant. The technical management of the mines and reduction works in Africa is being taken over by Anglo American Corporation. In March Rhodesia Broken Hill produced 1,750 tons of slab zinc, 113 tons of vanadium concentrates, and 12 tons of fused vanadium.

▶ Roan Antelope has declared an interim dividend of 30 per cent (1s. 6d. per share), which equals the total amount paid last year. The prospect now is that the net earnings of the company this year, if the price of standard copper should average £60 per ton, will be approximately £3,000,000, taking back what was considered a huge investment of capital in the short period of twelve months. The latest balance sheet shows that the enterprise represents a cash investment of £4,922,419. Its market value is approximately £25,000,000.

▶ Union Minière du Haut-Katanga's capital-reconstruction program is in effect. It will give the company the funds required to retire all outstanding bonds and obligations. Tanganyika Concessions, Ltd., as a large stockholder, is expected to benefit to the extent of £1,500,000 to £2,000,000.

South Africa

Nchanga Consolidated Has 143,000,000 Tons Reserve

Rhokana subsidiary to explore West orebody—Ore treatment question studied—Diamond trade shows improvement

▶ Promising to become one of the world's largest low-grade copper mines, the Nchanga Consolidated Copper Mines, Ltd., has been formed with a share capital of £5,000,000. This is a subsidiary of the Rhokana Corporation, which as early as 1931 conducted an active drilling program at the property in Northern Rhodesia. An ore reserve of over 143,000,000 tons has been disclosed, and the consulting engineers are certain further drilling would increase this tonnage. Prospects of disclosing other orebodies on the Mimbula Special Grant are good. The following tonnages have been disclosed:

	Tons	Total per Cent Copper	Oxide, %
Nchanga West	46,500,000	6.9	2.9
Nchanga River Lode	2,280,000	4.2	2.9
Chingola	2,000,000	7.0	6.6
Nchanga	93,000,000	3.51	2.25
Total	143,780,000	Avg. 4.66	2.53

▶ The Nchanga West figure includes 6,300,000 tons, containing 17 per cent copper, of which 4.5 per cent is oxide. A shaft-sinking and development program for opening the high-grade Nchanga West orebody had disclosed good ore. At the end of 1931, however, water flooded the workings, and the low price and the then uncertain outlook led to closing down. Preparations for reopening have been started and a program for early exploitation of the high-grade Nchanga West orebody has been drafted. The danger of flooding and other safety considerations have led to drawing of plans whereby two inclined haulageways and one new vertical shaft will be sunk in the footwall. One of these inclines will be separated from the mine by a concrete bulkhead and the other will be connected to the workings to provide an emergency means of escape. Development of the orebody and drainage of the overlying beds will be facilitated by this, and pumps can be run in it under all conditions, even if the mine were flooded. Although originally it seemed unnecessary to dewater the mine below the 470-ft. level, it has been decided that the proper course is to lower the water level to at least 1,000 ft. below the surface. Installation of new pumps, with a daily capacity of 25,000,000 gal. has started.

As the property contains large bodies of oxide ore the question of treatment is receiving attention. Tests have shown that satisfactory extraction of sulphides can be made and experience indicates that at least a part of the oxide copper should be recoverable by flotation. This process is more economical than leaching, which involves heavy capital expenditure and high running cost. Flotation tests on the ore will be made when it is available.

▶ DeBeers Consolidated Mines, Ltd., has published its report for 1936, revealing continued improvement of the diamond trade throughout last year. The demand for diamonds continues to expand, and prospects for 1937 are satisfactory. Expenditure was £639,700, leaving a balance of £2,930,800.

▶ In his address at the recent annual meeting of the Transvaal Chamber of Mines, the retiring chairman, G. H. Beatty, gave some interesting figures on the gold production of the Witwatersrand for 1932 (before South Africa went off gold) and 1936. The latter year was the fourth since the old standard of gold was shelved, and it is interesting to note comparison in the table below:

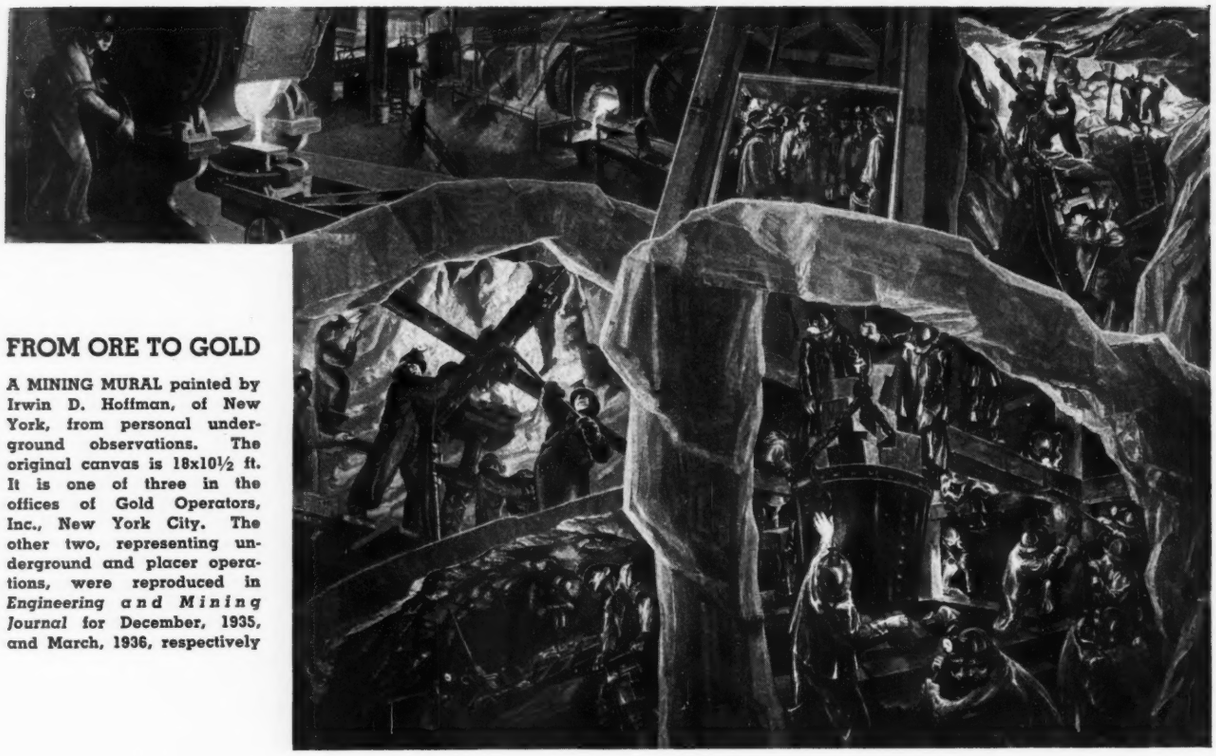
	1932	1936
Tons milled	34,906,450	48,221,120
Yield per ton—dwt.	6.481	4.569
Working revenue per ton	27s.0d.	32s.0d.
Working costs per ton	19s.0d.	18s.9d.
Working profit per ton	8s.0d.	13s.3d.

Quest for Iron Ore Keen In Great Britain—Boliden Mining Reduces Dividend

▶ Practically all known occurrences of iron ore in Great Britain are being reexamined and tested. This is prompted by a severe shortage in supplies of ore, pig iron, billets, and scrap. Three steel plants have had to close down temporarily for lack of raw material. An iron mining boom is in prospect.

▶ British Electro Metallurgical Company, formed recently by Sir Edmund Davis and associates, has started the erection of a plant in Sheffield for production of ferrochromium.

▶ Earnings of the Boliden Mining Company, in Sweden, were much smaller in 1936, being only Kr. 1,969,955, against Kr. 8,177,665 in 1935. These results were reached after writing off Kr. 6,697,000 and Kr. 6,273,078 respectively. The dividend was reduced to 15 per cent from 20 per cent the previous year.



FROM ORE TO GOLD

A MINING MURAL painted by Irwin D. Hoffman, of New York, from personal underground observations. The original canvas is 18x10½ ft. It is one of three in the offices of Gold Operators, Inc., New York City. The other two, representing underground and placer operations, were reproduced in *Engineering and Mining Journal* for December, 1935, and March, 1936, respectively

Australia

Wiluna Drilling New Area After Study of Geology

This West Australian Company floating stibnite ores and roasting and briquetting tailings—Mount Morgan develops recently found orebody

▶ Recent geological investigations by Wiluna Gold Mines, Ltd., have indicated the existence of an important fault zone with structural features favorable to ore deposition in an area about a half mile southeast of the company's property at Wiluna, W. A. A reservation has been obtained over this area and diamond drilling along the shear with a view of defining its strike and locating any possible orebodies is in progress. The first hole, located 5,900 ft. southeast of the main shaft, intersected ore averaging 6.6 dwt. per ton over a true width of 24 in. at a vertical depth of 400 ft.

▶ Stibnite ores from the Moonlight area are being floated to produce an antimony-gold concentrate, which is being shipped abroad for realization, and an arsenopyrite-bearing tailing, which joins the main flotation circuit of the Wiluna ore. After roasting the combined arsenopyrite concentrate, the calcine is now being bonded with 10 per cent slaked lime to form briquets, which are smelted direct, thus largely overcoming trouble previously experienced, in that sintering, which had proved difficult and costly, is now practically unnecessary.

▶ Golden Horseshoe (New), Ltd., which is re-treating the Great Boulder dumps, at Kalgoorlie, under a profit-sharing arrangement, is making a profit on joint account of £2,000 per month from treating approximately 40,000 tons per month. Costs are averaging 2s. 6d. per ton.

▶ A nine months' development program of diamond drilling, drifting, and crosscutting is in progress at Mount Morgan Mine, in Queensland, to ascertain the size and value of the new orebody recently located. Work to date has traced the body for 380 ft. on the 285-ft. level without delimiting it at either end. The width is not yet known—greatest to date is 105 ft. Samples taken so far average 6.9 dwt. The new oxidized ore-treatment plant is now in full operation and working satisfactorily. In the four weeks ended March 3, 12,600 tons were treated.

▶ Cocks Pioneer, working a gold and tin sluicing area at Eldorado, Victoria, has completed a twelve weeks' run in which 215,000 cu.yd. was treated for 1,036 oz. gold and 13.5 tons tin concentrate, the total proceeds being valued at £11,855, or 13.25d. per cubic yard. Working costs are estimated at 8d. The near-by Cocks Eldorado is dredging 50,000 cu.yd. weekly for a return of 150 oz. gold and 2.5 tons tin oxide per week.

▶ Lake George Mining Corporation, Ltd., has been incorporated with a capital of £1,100,000 sterling to finance the equipment of the Lake George lead-zinc mine at Captain's Flat, N. S. W. This property, which was extensively tested prior to the depression, has since been lying idle. Ore reserves are estimated at 2,880,000 tons assaying 7.5 per cent lead, 12.9 per cent zinc, 0.75 per cent copper, 2.2 oz. silver, and 1.3 dwt. gold per ton.

New York State's Rules On Silicosis

Effective May 1 the following rules approved by the Industrial Board of New York State apply to all rock drilling in silica-bearing rock, which is divided into two classifications:

1—"Any rock formation of substantially uniform geological character having free silicon dioxide as a component part which is known from geological studies or otherwise can be shown by the applicant (rock drilling employer) to the satisfaction of the Industrial Commissioner, to run uniformly less than ten (10) per cent by weight of the rock formation.

2—"All rock formations having free silica dioxide as a component part, ten (10) per cent or more by weight, and all other formations, natural and synthetic, having a variable and unpredictable content of free silicon dioxide."

The rules define "injurious silica dust concentration" as "dust produced from drilling silica-bearing rock which is in excess of the following values as determined by an approved dust count method:

1—"One hundred million (100,000,000) particles per cubic foot of air (as specified in No. 1 above).

2—"Ten million (10,000,000) particles (as specified by No. 2 above)."

All rock-drilling operations must be executed so that there will be no dissemination of injurious silica dust concentration into the atmosphere. Dust control may be effected by suction or exhaust, and wet methods when approved by the Industrial Board, and other methods which may be invented or developed in the future, providing they are approved by the Board. At time of going to press, equipment approved by the Board had not been announced.

PERSONAL ITEMS

Clinton Bernard is back in New York after two months' absence in Colombia.

Albert Burch has been in Reno on his return from Denver to his home at Medford, Oregon.

Arthur L. Walker has returned to New York from his recent trip to Australia and New Zealand.

T. R. Hunt has become metallurgist for the Pend Oreille Mines & Metals Company at Metaline Falls, Wash.

J. A. MacKillican, manager of the Meridan Iron Company at Hibbing, Minn., has returned from Honolulu.

Glenn L. Allen, mining and metallurgical engineer, formerly at Potosi, in Bolivia, has returned to the United States.

Sidney J. McCarroll has accepted the position of assayer at the Manning mill of Snyder Mines, Inc., at Salt Lake City, Utah.

Army Adams, of Grass Valley, Calif., has gone to Inyo County, in the same State, to sample and develop an ancient gravel channel.

S. G. Turrell, technical representative of North American Cyanamid, returned to Australia in February from a trip around the world.

Dale F. Underwood is on the staff of the Charleston Mining Company, at Mount Pleasant, Tenn. The company is mining phosphates.

John S. Stewart, of New York, has gone to London to make metallurgical studies for Selection Trust, Ltd., and its allied companies.

Max. H. Barber, district superintendent of the Cleveland-Cliffs Iron Company at Hibbing, Minn., has returned to that city from San Antonio, Tex.

B. M. Concklin, chief engineer for the Arthur Iron Mining Company, operating on the Mesabi range in Minnesota, has returned from Phoenix, Ariz.

Abe Mathews, superintendent of the Corsica and Biwabic mines of Pickands Mather & Company, recently spent a few weeks vacationing in Florida.

L. C. Moore, who is doing consulting work on an iron-ore project off the coast of Australia, is now in Singapore. He expects to be there for a few months.

Russell B. Caples, general superintendent of the Great Falls plant of Anaconda Copper Mining Company, was a recent visitor to New York.

O. D. McClure, of the Cleveland-Cliffs Iron Company, was recently in Hibbing. Mr. McClure is chief mechanical engineer and is located at Ishpeming, Mich.

Scott Turner has been made vice-president and member of the board of the International Mining Corporation, of New York City.

Horace G. Young has recently completed a tour of inspection of the properties in northwestern Ontario and the Kenora district in which he is

HORACE G. YOUNG

interested; namely, Wendigo, Red Crest, Lake Rowan, Cochenour-Willans, and West Red Lake Gold Mines.

Cecil C. Brebant has assumed the position of resident engineer with the Granby Consolidated Mining, Smelting & Power Company at Copper Mountain, B. C.

D. C. McKay, engineer residing until recently in Reno, has sailed for the Philippine Islands to take a position with the Benguet Consolidated Company.

C. E. Garnett has been elected president, **J. O. G. Sanderson,** vice-president, and **J. G. Spratt,** counselor of the Alberta Association of Professional Engineers.

M. W. Hayward, geologist for the American Metal Company, has returned to El Paso, Tex., after a six months' trip to the Western states, British Columbia, and Mexico.

T. L. Wells has resigned his position of general manager of Matachewan Consolidated Mines, Ltd., to engage in general consulting at 24 King St. West, Toronto, Ont.

W. B. Daly, general manager of mines, Anaconda Copper Mining Company, recently returned to Butte after spending several months in California and other points in the Southwest.

Donald Yates, general superintendent of the Broken Hill Associated Smelters, Port Pirie, S.A., has been elected president of the Australasian Institute of Mining and Metallurgy for 1937.

Ellis Davies, chief engineer of Chas. Ruwolt, Pty., Ltd., Richmond, Vic., and consulting engineer to the Emperor and Loloma companies, operating in Fiji, left on a visit to Fiji early in March.

R. H. Nelson, of the Taylor, Nelson & Knapp Company, which is operating in the Philipsburg and Silver Star districts of Montana, has been in Mexico on a brief business trip.

Augustus Locke, consulting geologist, of San Francisco, has severed his connection with the Eastern Exploration Company, of Goldfield, Nev., and resumed consulting work in British Columbia.

W. G. Mather, chairman of the board of directors, and **A. C. Brown,** vice-president, of the Cleveland-Cliffs Iron Company, have been elected directors of the Republic Steel Corporation.

Charles Mayotte, superintendent at the Buckhorn mine of the Pardners Mines Corporation, in Eureka County, Nev., has resigned because of ill health and is succeeded by **C. W. Van Law.**

Frederick C. Gilbert, metallurgist, of Butte, Mont., has been reelected secretary of the Montana section of the A.I.M.E. He is also secretary of the Mining Association of Montana.

David M. Reck, formerly with the Octave unit of American Smelting & Refining Company as assayer, is now chief chemist and assayer for the Banner Mining Company at Lordsburg, N. M.

H. A. Mann, until recently engineer with Carson Hill Gold Mining Corporation, Melones, Calif., has sailed for Manila, P. I., to join the staff of the I. X. L. Mining Company at Balete, Masbate, P. I.

L. D. Kipe writes from Grand Junction, Colo., that he is associated with **W. A. Harbison,** of 101 Park Ave., New York, in producing high-grade uranium and vanadium ores from properties in Grand County, Utah.

Paul A. Schafer, formerly a member of the faculty of the Montana State School of Mines, is now in the Philippine Islands as a member of the geological staff of the Benguet Consolidated Mining Company.

Orlando McCraney, president of California Sierra Gold Mines, Nevada City, Calif., left on the "China Clipper" on April 7 for Manila, P. I., where he will be associated with the Pan-Philippine Syndicate.

J. D. Stephens, engineer graduate of the Mackay School of Mines, connected with the University of Nevada, at Reno, has accepted employment in Bolivia with the South American Gold & Platinum Company.

Edgar M. Tennis has assumed his duties as mine manager at the Santa Eulalia unit of the American Smelting & Refining Company, in Chihuahua. Previously he had been on the staff of the company at the Parral unit.

Louis Koepel, a graduate of the Michigan College of Mining and Technology, at Houghton, has been appointed superintendent of the Quincy Mining Company's stamp mill in the Michigan copper district.

Helmer Hedstrom, a mining engineer of Stockholm, recently made a survey of industrial conditions in Canada and the United States in behalf of a group of Swedish capitalists served by his firm, the Swedish American Prospecting Corporation.

H. C. Mabee, chief chemist of the ore-dressing and fuel-testing laboratory of the Bureau of Mines at Ottawa, has retired after 23 years' service. Appropriate complimentary congratulatory ceremonies marked his relinquishment of the post.

Charles E. Segerstrom, president of the Nevada-Massachusetts Company, addressed the San Francisco section of the A.I.M.E. on April 14, his discussion being on tungsten. **P. R. Bradley, Jr.,** also addressed the meeting, speaking on the Atolia mine.

Vaupell & Garcia, mining engineering firm of Mexico, D. F., Mexico, have added a legal department to their organization. At its head will be **Genaro Garcia** and **Juan Garcia Aguirre,** well-known attorneys. The firm has also established an accounting and auditing section.

H. P. Koopmans, mining engineer and a member of the staff of Mauricio Hochschild & Company, Ltd., Bolivia, S. A., arrived in San Francisco on April 11. After a brief stay, during which he visited gold mines in the Grass Valley-Nevada City district, Mr. Koopmans left via Japan and Siberia for The Hague, Netherlands.

Edward A. Hammermeister, who for the last ten months had been acting as shift boss at the Central mine of the Lava Cap Gold Mining Corporation, at Nevada City, Calif., has accepted a position with the California-Philippine Engineering Company, Pilas Building, Manila, P. I. He sailed for Manila on April 24.

Ing. José Maria Garza Aldape, mining engineer and geologist, lately with the Cusi Mexicana Mining Company, Cusihuiriachic, Chihuahua, has returned to consulting work. His offices are at 805 Ocampo St., Chihuahua, Chih., Mexico. He is an alumnus of the Colorado School of Mines and the Stevens Institute of Technology.

Harry V. Welch, metallurgical engineer and specialist on dust and fume control problems for the Western Precipitation Corporation, of Los Angeles, Calif., sailed on April 24 from New York for a combined pleasure and business trip to South America. Mr. Welch will visit all the important mining and industrial districts on the South American continent and will be absent from the home office about six months.

Dr. Ing. Paul Schwarzkopf, of Reutte, Austria, metallurgist, has accepted presidency of American Cutting Alloys, Inc., New York City. Dr. Schwarzkopf is well known for his pioneering work in the field of powder metallurgy. He invented the titanium cemented carbides for cutting of steel at high speeds, that have had such a large use in Europe during the last two years.

Dr. P. M. Aderson, manager of the Union Corporation in Johannesburg and chairman of its South African auxiliaries, has been elected president for 1937 of the Transvaal Chamber of Mines. He hase been president twice before. **John Martin,** director of the Central Mining & Investment Corporation, Ltd., and chairman of Rand Mines, Ltd., was elected vice-president.

John Renning, recently with the Canyon Corporation, at Deadwood, S. D., has accepted a position with the Batong-Buhay Gold Mines, Inc., at Lubuagan, Kalinga, Mountain Province, in the Philippines, as assistant mine engineer and assayer. He expected to arrive at Manila on May 3.

Edward R. Clark, Jr., until March 1 last in the engineering department of Climax Molybdenum Company, at Climax, Colo., is now employed as an assistant engineer with the Anaconda Copper Mining Company at Butte, Mont.

Prof. John T. Stark, of the faculty of Northwestern University, at Evanston, Ill., has been appointed chairman of the department of geology and geography in place of **Prof. Charles H. Behre,** who has asked to be relieved of the chairmanship to devote more time to research. Professor Stark returns to the University in September after a year of field study of the geology of the Southern Pacific realm and attendance at the International Geological Congress in Moscow.

Harold F. Lynn, superintendent, Idaho-Maryland Mines Corporation, at Grass Valley, Calif., has been promoted to the position of manager of the company's extensive enterprise at Forbestown, Calif. **Albert Crase has been appointed general manager of the Grass Valley operations of the company, in addition to being elected to the board of directors.**

Glenville A. Collins, mining engineer, has been for several weeks past at the Silver Bell-Martinez mine, near Superior, Ariz. This property completed in December, 1936, a 50-ton flotation plant and is now treating silver-lead ores and shipping about four cars per month to the El Paso smelter and three cars of crude ore to Hayden. Development includes two 500-ft. shafts. A substantial tonnage has been blocked out. The mine is owned by the Sunbeam Gold Mining Company, which also owns a gold property near Kingman, Ariz., and is being operated by the Collins Pacific Company, as engineers and mine managers of San Francisco.

J. O. Greenan is now in Bandoeng, Java, where his address is c/o Marsman Investments, Ltd., Nillmy-gebouw. Mr. Greenan left Manila some months ago and established headquarters in Bandoeng and is now engaged in prospecting rather large areas scattered throughout the Netherlands East Indies, a country that has few mines, he says, the principal ones being the Billiton-Banka tin area and the Simau Lode gold mine, in Sumatra. Gold occurs widely nevertheless. At the date of writing, March 12, Mr. Greenan had just returned from Sumatra and was about to leave for Borneo.

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OBITUARY

Dr. Ozni P. Hood, 71 years of age, until recently chief of the technological branch of the United States Bureau of Mines, died on April 22, at Washington, D. C., after a long illness. Dr. Hood was retired June 30, 1936, after his term of office had been extended one year beyond the age limit by executive order. He had been a resident of Washington for the past twenty years. Before coming to Washington Dr. Hood served with the Bureau of Mines at Pittsburgh as chief mechanical engineer. Prior to joining the staff of the

DR. OZNI P. HOOD

Bureau of Mines he was professor of mechanical and electrical engineering at the Michigan College of Mines for thirteen years. From 1889 to 1898 he was professor of engineering at the Kansas State Agricultural College. Dr. Hood was an honorary member of the American Society of Mechanical Engineers, of the A.I.M.E., of the American Society of Heating and Ventilating Engineers, and of the International Railway Fuel Association. He was a member of the Washington Society of Engineers and of the Society for the Promotion of Engineering Education. Dr. Hood was born in Lowell, Mass., June 14, 1865. He was graduated from Worcester Polytechnic Institute in 1883 and from the Rose Polytechnic Institute in 1885. He held the degree of doctor of engineering from the latter institution.

Dean Leon B. Smith, geologist, head of Wesleyan College, at Macon, Ga., since 1930, died at Macon on May 4.

Frederick Wheeler Smith, chairman of the board and one of the organizers of the Mutual Chemical Company of America, an important factor in the chrome-ore industry, died on May 3 in his 73d year.

Reuben Norris Ivory, mining engineer of Park City, Utah, long identified with the development of Utah mining properties prior to 1917, in which year he became State engineer, a post he resigned only last year, died on April 17 in Salt Lake City at the age of 77.

Major W. A. Wills, long prominently identified with the development of South Africa, as a pioneer, an industrialist, and a journalist, died recently at the age of 74.

Woolf Carlis, one of the most colorful personalities of the Rand and one of its oldest pioneers, died recently at Johannesburg at the age of 86.

James H. Dopson, well-known Nevada enginer, died at Red Bluff, Calif., recently, at the age of 55. He was an authority on exploratory work for the Bureau of Reclamation at the Table Mountain and Kennett dam sites.

William Vergo Somerville, pioneer mine operator of the Yukon and at the time of his death president of Kalamalka Gold Mines, operating near Vernon, B. C., died in Vancouver on Feb. 13 last at the age of 74.

Walter T. Bleick, chief clerk of the Butte legal department of the Anaconda Copper Mining Company, died of pneumonia on April 8. Mr. Bleick was widely known throughout Montana mining circles and particularly for his generous civic interest in Montana.

G. D. Delprat, general manager of the Broken Hill Proprietary Company from 1899 to 1921, and prominently associated with the development of the flotation process at Broken Hill, and later with the establishment of the iron and steel industry at Newcastle, N.S.W., died at Melbourne on March 15; aged 81.

Benjamin F. Bauer, 72, veteran mining operator and president of the Salt Lake Hardware Company, Salt Lake City, Utah, died on March 27 at his home. Mr. Bauer was born in Eden, N. Y., on July 8, 1864. On coming to Utah in 1888, he became interested in mining and took a leading part in mining operations at Bullion Coalition mines, Annie Laurie Consolidated, and the Maxfield mine.

Walter Fitch, Sr., long prominently identified with the development of the Tintic mining district of Utah, died on April 23 at the age of 73. He had been associated with the mining industry for more than 60 years, having been manager of the United States Smelting, Refining & Mining Company, superintendent of Calumet & Hecla, and at the time of his death president of Chief Consolidated Mining Company, an office which he held since its organization in 1908.

J. T. Shimmin, metallurgical engineer, and mill superintendent with Buchans Mining Corporation, Ltd., at Buchans, Newfoundland, since Sept. 1, 1935, died in Buchans on April 7 as a result of an operation for appendicitis. He would have been 50 years old on April 25. Mr. Shimmin specialized in the treatment of low-grade copper ores, being among the first, also, to recognize the important part that copper sulphate plays in the flotation of zinc. He had been manager of San Juan Metals Corporation, Telluride, Colo., and had had charge of metallurgical work at the Sunshine mine, at Kellogg, Idaho, at which property he constructed a flotation mill in April, 1935. He was a member of the A.I.M.E. He leaves a record of fine achievement and service, in which he was an inspiration to his younger professional associates.

Dr. Alfred Douglas Flinn, Director of the Engineering Foundation, died March 14, 1937, at the age of 68, after a prolonged illness. Dr. Flinn was born in New Berlin, Pa., and received his engineering training at the Worcester Polytechnic Institute, followed by special studies at the Massachusetts Institue of Technology. He specialized in civil engineering. From 1895 to 1902 he was connected with the Massachusetts Metropolitan Water Works at Boston, and after a few years with the *Engineering News-Record,* which he served as managing editor, he joined the engineering staff of the Board of Water Supply of New York City. He served this Board from 1905 to 1918 in various capacities, being largely instrumental in working out the plans for the Catskill Aqueduct, and for the development of the Esopus and Schoharie watersheds. In 1918, Dr. Flinn resigned to become secretary of the United Engineering Societies and of Engineering Council. In 1922, he was appointed Director of The Engineering Foundation, which position he held continuously until his death. Dr. Flinn was the recipient of many honors, including the honorary degree of doctor of science from the University of Louvain in 1927 and doctor of engineering from Worcester Polytechnic Institute in 1932. He was an honorary member of the Masaryk Academy of Prague and "Knight, Order of the White Lion" of Czechoslovakia.

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Letters

"Where's the Miner's Family?"

The Editor:

WHAT are the big mining companies doing about the housing situation for employees? Particularly during the great demand for metals and subsequent search for experienced labor, it would seem that it is time for mining concerns to build adequate, comfortable lodgings for employees, which in turn would make for a better class of miner.

To the average mind, the word "miner" brings forth a picture of a fly-by-night sort of fellow, with no home ties, spending his salary as fast as it is earned and drifting from place to place. This is true to a certain extent, but often it is made true by the fact that mines sometimes do not provide adequate living facilities for the ambitious, hard-working, family-loving individual.

For instance, one large mining company has a 75 per cent labor turnover. Some of this is due to the type of miner who drifts there and stays for a time and moves on, but principally it is because of the fact that the company provides no adequate housing facilities. This mine is located at an extremely high altitude, where the summer is short, even the nights in July and August are chilly, and snow falls early in September. Yet, this past fall, during very cold weather, miners were living in rudely built shacks and tents, which they had built themselves and which proved poor protection against the cold weather. This is a deplorable situation, not only for the miners who work there but it does not make for a contented, loyal employee who will give his best for his employer.

Often the miner is forced to leave his family in a distant town, while he works elsewhere. And in this instance the question may be asked, "Can a man give his best efforts to a company if, at the same time, he is separated from his family, worrying about their welfare and health, to say nothing of the expense of keeping up two establishments?"

Though it is to be realized that the building of company houses entails large expenditures, it is my opinion that the company doing so is repaid many times by attracting better workmen.

A MINER'S WIFE

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Surveying a Steep Winze Without an Auxiliary Telescope

The Editor:

I HAVE read "Surveying a Steep Winze Without an Auxiliary Telescope" in the January issue of *E.&M.J.,* and have often thought of the problem. The writers do not claim originality; the method is described in textbooks on surveying. My plan is not original. I draw upon instruction given in most books on surveying for making exact measurements with the instrument out of adjustment.

Incline the plate of the transit so that top and bottom of the winze can be seen. Level as near as possible with the telescope bubble at right angles to the line of sight. Set P_1-P_2 at the top and P_3-P_4 at the bottom. Invert telescope and move upper plate exactly 180 deg. Make four other marks and mark the mean point at the four points.

Move and the upper plate 90 deg. and bring the telescope back to the last sight with the lower motion. Repeat the whole, getting a second set of mean points. The mean of the means should furnish two points at the top and two at the bottom, all of which are in the same vertical plane. Connections can be made in the ordinary way.

There will be two opportunities to read vertical angles, and slope distances made in the usual way. One reads the vertical angle with the bubble level, and at the target in the bottom. As the reading will go over 90 deg., one must count beyond 90 deg. or use other vernier, but in any case one must be alert that a mistake is not made.

A special measurement may be necessary to transfer the co-ordinates. That will depend on conditions. If the roof is high enough, P_1 might be placed with telescope overhead.

Benton, Ark. DONALD S. TEDFORD

NEW BOOKS

METALLURGY OF LEAD AND ZINC. *Compiled by the A.I.M.E. Technical Committee on Reduction and Refining of Lead and Zinc. Published by American Institute of Mining and Metallurgical Engineers, New York, N. Y. Pp. 748. Illustrated. Price $2.50 to members, $5 to non-members.*

THIS VOLUME contains a group of papers specially solicited for the purpose from well-known authorities in various phases of lead and zinc metallurgy. In addition to new and hitherto unpublished material, it contains articles on current practice, so that it may be said to represent the state of the art as of 1936. On the subject of lead there are articles dealing with sintering, blast-furnace practice, the refining of base bullion, and the collection of dust and fume. The section on zinc deals with sintering and roasting, horizontal and vertical retort practice, electrothermic smelting, and electrolytic production. Contributions from authorities in Canada, Australia, Peru, England, Germany, Tasmania, Sweden, and the United States give the volume an international flavor.

"DIE NUTZBAREN MINERALIEN, Gesteine *und Erden Bayerns." II Band: Franken, Oberpfalz und Schwaben nordlich der Donau. Bayerisches Obergamt, Munchen, 1936. Pp. 512.*

THIS VOLUME is the second part of a projected three-volume treatise on the Mineral Resources of Bavaria, the largest southern province of Germany. It was prepared by a group of geologists and chemists under the direction of Professor Dr. Mattheus Schuster and is published by the Bureau of Mines of Bavaria.

Volume I, published in 1924, covered the northeastern section of the province, which, for the most part, consists of a series of mountain ranges (Paleozoic crystallines) along the Czechoslovakian border.

The present volume (II) includes the remaining region north of the Danube, a river which serves as the geographical boundary between two roughly equal land areas generally referred to as North and South Bavaria.

A large part of the book is devoted to the general and economic geology of the predominant Mesozoic and Cenozoic sediments of the region, arranged in stratigraphic order. Separate chapters cover scattered areas of Paleozoic crystallines and post-Paleozoic volcanics. A discussion of the metallic and non-metallic mineral deposits (120 pages) follows, and is organized along similar systematic lines. Worthy of mention, also, is an appendix which includes information on mineral waters and recent geologic data concerning the area presented in Volume (I) (1924).

The thorough method of treatment is best illustrated by the discussion of the famous Lithographic Limestone from Solnhofen. We find an account of its age and origin, a detailed description of the rock and its occurrence, a list of physical and chemical properties and their technological importance, its commercial usage and application, quarry localities, and a historical commentary. In addition, excellent photographs, geologic cross-sections and maps, stratigraphic correlation tables, and block diagrams illustrate the written word. Following the modern trend in geology, the chemical aspects of the subject receive considerable attention, and the results of chemical analyses of rocks and minerals are frequently included in the text.

This book is the result of painstaking and exhaustive effort and presents a wealth of facts in a concise and well-organized manner. It will undoubtedly prove its worth as a reference work for the economic geologist and in some measure for the stratigrapher, but it is less suitable for the student who wishes to gain a general picture of the economic geology of Northwestern Bavaria. The presentation is entirely factual and discussions of geological ideas and principles are avoided. The German is rather simple, though replete with scientific terminology, and should not prove a serious obstacle to anyone with a general reading knowledge of the language.

KURT E. LOWENSTEIN

QUIN'S METAL HANDBOOK AND STATISTICS, 1937. *Published by Metal Information Bureau, Ltd., 79 Mark Lane, London, E.C. 3, England. Pp. 325. Price 5s.*

A VALUED HANDBOOK of metal and market statistics and related information that now makes its appearance for the 24th year. In such cases it is difficult to say anything new, but all interested in the metal market will find it useful.

MINING MANUAL, 1936-37. *Statistical Research Bureau, San Francisco, Calif. Annual subscription $10.*

THE PUBLISHERS have changed the form of this reference work from a bound volume, last published in 1935, to a sectional manual contained in an adjustable binder. The change is intended to make it possible to keep the contents up to date by frequent additions to the various sections. Distribution of the 1936-37 edition has begun with Section 1 and will be followed by others throughout the year. In addition to describing the principal mining enterprises in North America, special sections will cover production statistics, glossary of mining terms, "Who's Who in Mining," "What's What in Mining Equipment," data on mining securities, and maps of mining districts in the Western United States.

PUBLICATIONS

RECEIVED

✦ *Research Studies, With the Aid of Models, Into the Distribution of Stresses and Deformation Underground.* The following two papers appeared in Forschungsheft 372, brought to our attention recently by V.D.I.—Verlag, Berlin:

✦ *Modellversuche zur Klärung der Spannungsverteilung in der Umgebung von Strecken in Gebirge.* By Doz. Dr. Ing. E. Lehr, Berlin, and Bergrat K. Seidl, Breslau. Pp. 22, with 89 illustrations.

✦ *Modellversuche an Balken auf elastischen Unterlage zur Klärung der Spannungsverteilung in Hangenden von Abbaörtern.* By E. Lehr. Pp. 11, with 36 illustrations.

✦ *L'Emploi de l'Avion pour les Recherches Géologigues et Miniéres dans les Pays Neufs.* By F. Blondel. Reprinted from La Chronique des Mines Coloniales, Paris. Pp. 16.

✦ *South Dakota, Mining Industry of.* By F. C. Lincoln, W. G. Miser, and J. B. Cummings. Bulletin 17. South Dakota School of Mines, Rapid City, S. D. Pp. 201.

The National Department of Mineral Production of Brazil at Rio Janeiro has recently issued the following bulletins among others. Readers should note that they are written in Portuguese:

✦ *Geographical Prospecting in San Paulo.* By Irnack Carvalho de Amaral and Henrique Copper Alves de Souza. Bulletin No. 10, pp. 100, plus maps.

✦ *Mining Code, of July 10, 1934, and subsequent laws.* Pamphlet No. 6, 1936. Pp. 40.

✦ *Tantalum, Niobium, Uranium and Radium in Brazil.* By Othon Henry Leonardos. Bulletin 11. Pp. 56.

✦ *Mica.* By Nero Passos and Joaquim Miguel Arrojado Lisboa. Bulletin 12. Pp. 55.

✦ *Quartz.* By Othon Henry Leonardos and Luciano Jacques de Moraes. Pamphlet No. 11. Pp. 16.

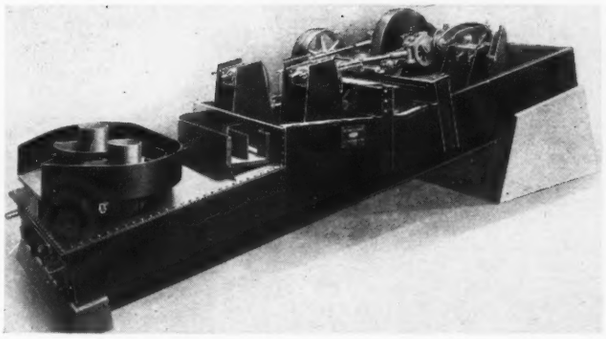
✦ *Chromite Deposits of the State of Bahia.* By Avelino Ignacio de Oliveirs. Pamphlet No. 12. Pp. 8.

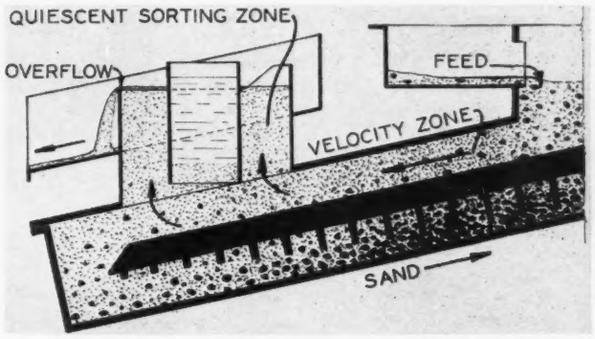
✦ *Barite, near Araxa, Minas Geraes.* By Avelino Ignacio de Olveira. Pamphlet 10. p. 11.

✦ *Diamond-bearing Sediments of Parana.* By Victor Oppenheim. Pamphlet 9. Pp. 15 plus map and plates.

✦ *Geologic-time Chart of Brazil.* By Djalma Guimaraes. Special Publication No. 1 of the Brazilian Institute of Mining and Metallurgy. Pp. 7.

EQUIPMENT NEWS





New Dorr Multizone Classifier

THE DORR COMPANY, Inc., of 570 Lexington Ave., New York City, has introduced a new type of classifier, to be known as the Dorr multizone classifier, for better all-around classification at all separations up to and including 80 mesh. The distinctive feature of this new classifier is the utilization for the first time of a combination of turbulence, high pulp velocity, and quiescent overflow to obtain a cleaner sand product and a more readily controlled overflow. A test program of several years preceded the announcement of this new classifier, thirty of which have been quietly placed in commercial operation in the United States, Canada, South Africa, and Australia to check results prior to public announcement.

The lower or overflow end is decked over and is surmounted by one or more circular overflow columns of variable cross-sections. Feed is introduced near the middle of the machine and passes downward and under a vertical baffle and then along the underside of the deck to the base of the overflow columns. The raking mechanism remains the same and is of the modern Dorr F construction with the FX type available for extra heavy-duty and high sand-raking capacities. Sizes range in width from 3 ft. to 16 ft., with rake mechanisms of the simplex and duplex type for the small mills, and triplex and quadruplex for the larger ones.

This new type classifier is said to provide several separate and distinct zones for controlling the separation of sands and slimes. Particular importance is reported placed on the control of the so-called critical size particles, those difficult particles close to the mesh of separation that tend sometimes to become associated with the coarse sands and sometimes with the fine slimes.

The first zone is a restricted, turbulent area of high pulp velocity, extending between the top of the reciprocating rakes and the lower side of the deck. Here, turbulent, high-velocity flow is utilized to maintain the fine and critical size particles in suspension, thus preventing their settlement and entrainment in the sand product. In the lower end of the classifier, the pulp flow is turned sharply upward and enters one or more vertical sorting columns, containing pulp in a quiescent condition. These columns constitute the second zone of classification. In rising quietly through these columns to the point of slime overflow, the pulp frees itself of the stray oversize, which drops against the slowly rising pulp stream to the bottom of the tank. Provision is made to vary the velocity at will by varying the annual cross-section of the column. This is effected by the use of interchangeable cylinders of different diameters which blank off either greater or smaller concentric portions of the column.

The manufacturers state that the new classifier combines with the well-known principles of mechanical classification some hitherto unutilized principles of hydraulics. Turbulence and velocity serve to prevent contaminating fines and critical size particles from getting into the sands; and quiescent settling at controlled velocities finally cleans up the overflow product by giving oversize and critical sizes an additional opportunity to separate out. Sand from this type of classifier is said to be cleaner, more granular, and of greater average coarseness than the straight classifier sand, resulting in less finished slime being returned to the ball mill.

The overflow was reported found to be finer at the finer meshes. This was said to be a result of the classifier's removal from the ball-mill discharge, as an overflow product, of 1.8 per cent more 48 mesh, 4.8 per cent more 65 mesh, 5.0 per cent more 100 mesh, 9 per cent more 150 mesh, and 9.4 per cent more 200 mesh. The volume of pulp directly above the reciprocating rakes is a fraction of that in the conventional open-tank classifier. This results in less live weight to support and less tendency toward surging and general unbalancing. Though the classifier responds readily to the usual adjustments of dilution, slope, and rake speed, the effects on the grinding circuit of sudden changes in dilution or feed are said to be minimized.

Rake-lifting devices have been discontinued, having proved unnecessary according to the company. With such a small amount of pulp in the tank, the segregation in case of a shutdown is said to be slight and the mechanism may be started up readily without raising the rakes and without draining the tank. The manufacturer says the advantages of the Dorr multizone classifier may be utilized either as additional grinding-mill capacity or else as additional fineness, whichever is most attractive under the conditions prevailing at the property. The device is said to possess the advantages of requiring less operating attention, of better over-all control of separations, of greater flexibility under fluctuating conditions, and the ability to start up after a shutdown, fully loaded and without operating a lifting device.

Ground Wire Bracket

TO PROVIDE a suitable means of supporting suspension clamps for overhead ground wires on wood pole lines, the Ohio Brass Company, Mansfield, Ohio, has developed a ground wire bracket which prevents the loss of considerable pole height. In the design of such lines it is the usual practice to install a pole extension above the crossarm. The new fitting allows the ground wire to be at-

tached to the pole itself, eliminating the need for an extension and using only 1¾ in. of headroom. In combination with the suspension clamp commonly used with ground wires, the device sacrifices only 3¾ in. of the pole height. Aside from this advantage the bracket is said to have other desirable features. It is made of malleable iron, hot-dip galvanized, and is said to have ultimate strengths of approximately 8,000 lb. for vertical loads and 5,000 lb. for horizontal loads.

Screw Take-up

A NEW PROTECTED SCREW take-up for conveyors and elevators is announced by the Jeffrey Manufacturing Company, Columbus, Ohio. The adjusting screw is said to be protected from dust and dirt by an inverted-U-shaped shield

which extends from end to end of the take-up frame. The sliding-base casting, which carries an adjustment nut of bronze, is reported cored out in such a way that it slides freely over the shield, thus relieving the shield of any function other than that of protecting the screw. As the adjusting screw does not travel, but remains inside the frame, it is considered protected from damage and operating strains and shocks.

Structural Rib Bolt

THE AUTOMATIC Nut Company, Inc., of Lebanon, Pa., manufactures a structural rib bolt and nut which the company believes is a practical substitute for riveting. The triangular-shaped ribs embed themselves in the wall of the whole of the work in the erection of building, bridges, tanks, towers, or cars. For placing the bolt the only equipment necessary is a hand hammer and an ordinary wrench. The Anco-nut is placed on the rib bolt in the ordinary manner and the manufacturer states it will not work loose. A small locking pin on the nut travels between the threads of the bolt and automatically assumes a fixed angle and establishes a point of impingement against the bolt—the pin biting into the body of the bolt, thus maintaining an anchorage against vibration and shock. To remove the nut merely exert sufficient pressure with a wrench and the pin moves to a different angle, removing the rachet action of the pin, permitting free removal of the nut.

Four-Wheel Scraper

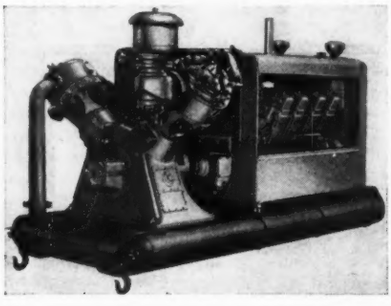
BUCYRUS-ERIE COMPANY, South Milwaukee, Wis., announces a new four-wheel scraper for the excavating field. Using a three-point suspension, and with ample clearance to swivel the front wheels under the frame, this scraper can be maneuvered in short, sharp turns, making a complete circle within the radius of its own length. Because all four wheels are inside the path of the cutting edge, it digs full width in close quarters and cuts close against the bank or other obstructions.

Its dumping action is said to be simple, fast, and positive. The bowl backs away and tilts forward sharply, while the apron tips and slides ahead—both to an almost perpendicular position. Said to be of simple, strong construction, the box-welded frame which carries the unit resists both tortional and tensile stresses set up in scraper operation. Welded plates of high-tensile strength alloy steel form the bowl and the apron.

The replaceable cutting edge of high-carbon manganese steel is supported on a rigid, heat-treated, steel casting, welded into the bowl, operating over a minimum number of sheaves from the drum power unit on the tractor. One control lever, conveniently placed, gives the operator instant and positive control of his loading, hauling, dumping, and spreading operations. The cable control is said to be efficient, and a 40-hp. tractor can easily load and heap the 4½-cu.yd. struck-measure scraper in ordinary material. The scraper described is manufactured in two sizes respectively of 4½-cu.yd. and 7-cu.yd. capacity level measure.

Air Compressor

SULLIVAN MACHINERY Company of Michigan City, Ind., announces a new line of "V" Vertical air compressors particularly suited to construction, tunneling, and mining where air capacities greater than obtainable from portable compressors are desired. Known as the WN-102 series, these compressors are available in three sizes: 445, 550, and 720 cu.ft. per minute actual air delivery (displacement 536, 660, and 856 cu.ft. per minute).



The design is two-cylinder "V" type, two-stage and double acting. These compressors are said to be compact and can be moved from one job to another by truck or trailer. Each size is self-contained and requires no water-service connections for cooling. Any type of drive—direct-connected, "V" belt, or flat belt—can be used, with diesel or gasoline power units or electric motor. Complete units, consisting of compressor and power unit on skid-type bases, or the compressor only, can be supplied.

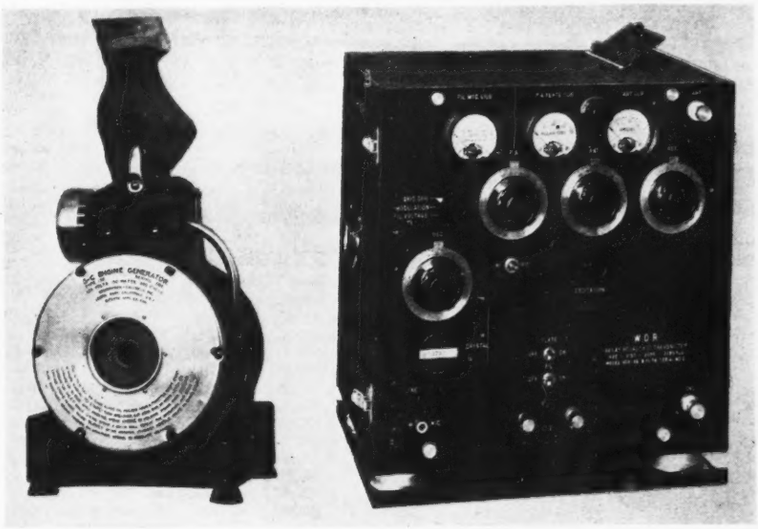
New Ball Bearings

TO MEET the severe problems of shock loads, vibration, and wear coincident with the operation of mining machinery, the Fafnir Bearing Company, of New Britain, Conn., has recently added a new series of high-capacity ball bearings to its present extensive range of types and sizes. Using as a basis the single-row radial design, the new bearings are furnished in the heavy-duty series but with specially designed, sturdy, wear-resistant bronze retainers to take care of these extra-duty requirements. Rugged, dependable, and accurately fabricated so that they will be exactly balanced in operation, they are said to fulfill all demands imposed by this field.

Light-Weight Portable Two-Way Radio Communication Transmitter and Receiver

LEAR DEVELOPMENTS, INC., of 121 West 17th St., New York City, N. Y., have developed a light-weight portable transmitter and receiver, specially intended for use in the bush countries and where communication is irregular and difficult and where telegraph lines are non-existent. It has found acceptance in some mining companies, and exploration parties are said to have found advantages in its use. One of the first applications to be made with these units was by a gold-mining organization in British New Guinea, where it was necessary to have reliable communication of between 150 to 300 miles both day and night.

The receiver works into a small loud speaker, which is said to be heard for a considerable distance, eliminating the necessity of continuously wearing headphones while awaiting a scheduled contact. Headphones are provided should this type of reception be desired. When the headphones are plugged in, the loud speaker is automatically turned off. An anti-noise type of close-talking microphone is provided. It has a button which, when depressed, turns off the receiver and turns on the transmitter. The same antenna is used for both the receiver and transmitter. Adjustments necessary are limited to tuning the antenna circuit, which is a simple operation.



The unit consists of a small gasoline-engine-driven alternator, said to be capable of delivering 200 watts of power at 110 volts. This alternator supplies the filament and plate voltage for the transmitter-receiver. The engine-driven alternator is inclosed in a substantially designed Duralumin case to protect it from accidental mishandling. It weighs 25 lb. and is designed for either mule-back or back-pack portability. The transmitter and receiver are said to be crystal frequency stabilized, to insure that no mistuning will prevent the completion of scheduled contacts. The unit puts out between 20 and 30 watts, 100 per cent modulated, on telephone and the same power on telegraph. It is basically designed as a telephone transmitter-receiver. However, owing to the greater transmitting range of continuous wave or telegraphy, provisions have been made to use it when necessary. It has seven tubes in all and is simply designed and constructed, with a special view to the requirements. The manufacturers say it can be operated for a long period without service or adjustment. It is supplied with an antenna especially designed for extremely effective transmission from rocky or poor subsoil terrain, and, it is said, only a few minutes are required to set up and operate. The engine alternator runs with any ordinary type of gasoline.

The unit is designed to work on any frequency range from 3,000 to 10,000 kc., or from 30 to 100 meters. However, experience has indicated a selection of a frequency around 5,000 kc. as preferable for communication both day and night up to 300 miles, the design based on two such units being used—one at the base and one at the field of operation—both tuned to the same frequency and held there by the piezo crystal oscillator, which is said to eliminate the necessity of tuning.

Gasoline consumption is about one pint per hour. The gasoline tank holds one quart, which is sufficient for three hours' run. One-quarter pint of oil is also contained in the crankcase and is circulated by a pump. This is said to be a sufficient quantity for fifteen to twenty hours' operation.

Suspension Clamp

EXPANDING ITS LINE of suspension clamps to provide the size for every need, the Ohio Brass Company, of Mansfield, Ohio, has added a clamp with a 0.7-in. cable seat diameter. Thirteen clamp sizes, from 0.4 to 2.25 in., are now available. The new size is said to be suitable for 350,000-circ.mil copper cable, 250,000-circ.mil copper cable with liners, 266,800 circ.mil steel-reinforced aluminum cable, or 4/0 steel-reinforced aluminum cable with liner. The clamp can be furnished with a J- or U-bolt, with or without liners and with or without socket fitting. Its over-all length is 7⅛ in.

BULLETINS

Welding and Cutting Apparatus. Victor Equipment Co., Welding Division, 844-850 Folsom St., San Francisco, Calif. A well-illustrated catalog, with information in regard to construction, types, and prices of welding equipment, attachments, and auxiliaries. Part of the booklet describes manufacturing and sales facilities of the company. Pp. 80.

Electrostatic Precipitates. Pangborn Corp., Hagerstown, Md. Bulletin 904 describes the development by Westinghouse Research as applied in the industrial air-cleaning field by Pangborn Corp. Pp. 5.

Agitair Flotation Machine. The Galigher Co., Booth-Thompson Division, Salt Lake City, Utah. Agitair Bulletin 363 describes and illustrates the "Agitair" flotation machine developed by Lionel E. Booth and John W. Thompson. Pp. 16.

Valves. Kennedy Valve Manufacturing Co., Elmira, N. Y. Bulletin 47 describes a new line of fully bronze-bushed standard iron-body wedge gate valves by the manufacturer. Pp. 5.

Steam Turbines. Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1181 illustrates in attractive manner the company's standard line of high-pressure, non-condensing, steam turbine units of the three-valve reaction type. Pp. 20.

Data Book. Productive Equipment Corp., 4600 South Kedzie Ave., Chicago, Ill. The research department of the company gives complete data on controlled vibration and screen efficiency. The publication is well illustrated and contains tables and graphs and dimensions of the Selectro screens. Pp. 32.

Boilers. Edge Moor Iron Works, 30 Rockefeller Plaza, New York, N. Y. Catalog 102 describes various types of water tube-boilers and accessories and contains striking black and white prints of the units covered by the publication. Pp. 20.

Pulsating Jig. Pan-American Engineering Corp., Ltd., 820 Parker St., Berkeley, Calif. Bulletin PJ describes the new type pulsating jig for gold concentration. Pp. 4.

Electric Lamp. Dewar Manufacturing Co., 26-34 35th St., Brooklyn, N. Y. Folder describes electric lamp for various uses. Pp. 4.

Respirators. H. S. Cover, Station A, South Bend, Ind. Small folder describes the improved Dupor Plate Respirator approved by the U. S. Bureau of Mines. Pp. 4.

Fans. American Blower Corp., Detroit, Mich. Bulletin A-701 illustrates sizes and types of the Sirocco fan for air-conditioning, heating, ventilating, and industrial applications. Numerous capacity tables and pressure ratio charts are included. Pp. 94.

Safety Hat. Davis Emergency Equipment Co., Inc., San Francisco, Calif. Bulletin 801 describes the McDonald Safety Hat. Pp. 4.

Drifters. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-1200-B21 lists the specifications, applications, and features of screw-feed drifters. Pp. 4. Bulletin W-1200-B8B describes the Worthington Rock Master, a light-weight movable drill rig. Pp. 11.

Data Book. Silent Chain Drive by Link-Belt Co., 307 North Michigan Ave., Chicago, Ill. Book 125 has a pliable cover and measures 8¼ x 11 in., is well illustrated, and has numerous useful tables on chain drives and drive accessories. Pp. 95.

Autodrifters. Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y. Folder describes the manufacturer's new automatic feeding rock drill. Pp. 4.

Wire Rope. Macwhyte Company, Kenosha, Wis., folder describing hoisting cable. Pp. 4.

Melting Furnace. Monarch Engineering & Mfg. Co., Curtis Bay, Baltimore, Md. Sheet series 154, describes bottom-pour simplex furnace. P. 1. Series 103 describes small furnaces for capacities from 500 to 4,000 lb. P. 1.

Summary of the

MARKETS

OPPOSITION to rising prices in Washington, a tightening of credit or "margin" requirements in London aimed at curbing speculation in that center, and disquieting rumors about $35 gold, subsequently denied in official quarters, halted the boom in non-ferrous metals and brought the markets back to a healthier position. Prices broke sharply, particularly in London, where liquidation took on substantial volume.

The *E. & M. J.* index of non-ferrous metal prices for April was 98.62, against 103.78 in March and 72.27 a year ago.

Following the break abroad, domestic producers of lead lost no time in revising their quotations downward, establishing the market on the basis of 6c., New York, at which level a fair business developed and the tone steadied. The recent high in lead was 7¾c.

Under pressure of increased offerings by custom smelters, resulting from a larger intake of scrap and limited demand, producers of copper marked down the price from the recent high of 17c., Valley, to 14c. President Roosevelt's warning on copper prices on April 2, and, later in the month, the news that the Government had started a suit against the Aluminum Company of America under the anti-trust law, disturbed the industry. Domestic sales of copper in April totaled 26,143 tons, against 53,101 tons in March. Foreign producers have virtually agreed to restrict production to 105 per cent of standard, beginning June 1, as mine output abroad is held to be running in excess of requirements. On Jan. 14 all restrictions on output abroad were removed.

Prime Western zinc remains strong statistically, yet sellers were forced to lower the price to 6.75c., St. Louis. Tin was easier in sympathy with other metals.

UNITED STATES MARKET

1937 April	Electrolytic Copper—Domestic (a)	Electrolytic Copper—Export (b)	Straits Tin New York	Lead—New York	Lead—St. Louis	Zinc St. Louis
1	16.775	16.625	63.625	6.95	6.80	7.50
2	16.775	16.075	62.625	6.90	6.75	7.50
3	16.775	16.075	62.625	6.90	6.75	7.50
5	16.775	15.750	62.875	6.90	6.75	7.50
6	15.775	15.525	61.700	6.90	6.75	7.50
7	15.775	14.600	60.250	6.00	5.85	7.00 @ 7.50
8	15.275	15.000	60.250	6.00	5.85	7.00
9	15.275	15.200	60.500	6.00	5.85	7.00
10	15.275	15.250	61.250	6.00	5.85	7.00
12	15.275	14.900	60.000	6.00	5.85	7.00
13	15.275	14.850	60.600	6.00	5.85	7.00
14	15.275	15.000	61.000	6.00	5.85	7.00
15	15.275	15.025	59.800	6.00	5.85	7.00
16	15.275	14.800	58.500	6.00	5.85	7.00
17	15.275	14.800	58.500	6.00	5.85	7.00
19	15.275	14.400	57.375	6.00	5.85	7.00
20	14.275	13.525	56.375	6.00	5.85	6.75
21	14.275	13.875	58.000	6.00	5.85	6.75
22	14.275	14.050	59.500	6.00	5.85	6.75
23	14.275	14.250	57.250	6.00	5.85	6.75
24	14.275	14.250	57.000	6.00	5.85	6.75
26	14.275	13.900	55.375	6.00	5.85	6.75
27	14.275	13.600	57.250	6.00	5.85	6.75
28	14.275	13.600	56.000	6.00	5.85	6.75
29	13.775	13.475	55.000	6.00	5.85	6.75
30	13.775	13.600	55.250	6.00	5.85	6.75
For month average	15.121	14.692	59.172	6.175	6.025	7.010
AVERAGES FOR WEEK						
April						
7	16.442	15.775	62.283	6.758	6.608	7.458
14	15.275	15.033	60.600	6.000	5.850	7.000
21	14.942	14.404	58.092	6.000	5.850	6.917
28	14.275	13.942	57.063	6.000	5.850	6.750
CALENDAR WEEK AVERAGES						
April						
3	16.525	16.613	63.917	6.933	6.783	7.500
10	15.692	15.221	61.138	6.300	6.150	7.208
17	15.275	14.896	59.733	6.000	5.850	7.000
24	14.442	14.058	57.583	6.000	5.850	6.792

SILVER, GOLD, AND STERLING EXCHANGE
NEW YORK AND LONDON

1937 April	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver (c) London	Gold London	Gold (d) United States
1	4.89375	4.88625	45.2500	20.8750	142s 1 d	$35.00
2	4.89250	4.88500	45.2500	20.8750	142s 1½d	35.00
3	4.89875	4.89125	(e)	21.0000	142s	35.00
5	4.90250	4.89500	46.6250	21.3750	141s 11 d	35.00
6	4.90625	4.89750	46.7500	21.5000	141s 7 d	35.00
7	4.89875	4.89125	46.0000	21.1250	141s 9 d	35.00
8	4.89125	4.88375	45.8750	21.0000	141s 11½d	35.00
9	4.89125	4.88250	46.1250	21.0625	141s 9½d	35.00
10	4.90000	4.89375	(e)	20.9375	141s 8 d	35.00
12	4.89750	4.88750	46.0000	21.0625	141s 8 d	35.00
13	4.90750	4.89750	46.0000	21.1250	141s 6 d	35.00
14	4.90625	4.89500	45.7500	20.9375	141s 6½d	35.00
15	4.90750	4.89625	45.5000	20.8125	141s 6 d	35.00
16	4.91500	4.90500	45.2500	20.6875	141s 5½d	35.00
17	4.91625	4.90500	(e)	20.6875	141s 2 d	35.00
19	4.92125	4.91000	45.2500	20.6875	141s 2 d	35.00
20	4.92000	4.90875	44.7500	20.5000	141s 1 d	35.00
21	4.92625	4.91375	44.7500	20.5000	141s 1½d	35.00
22	4.93875	4.92375	44.7500	20.3125	140s 7½d	35.00
23	4.93000	4.91625	44.7500	20.1875	140s 8½d	35.00
24	4.93000	4.91500	(e)	20.3750	140s 9½d	35.00
26	4.93375	4.91875	44.8750	20.3125	140s 9½d	35.00
27	4.94250	4.92750	45.0000	20.2500	140s 5½d	35.00
28	4.94125	4.92625	45.3750	20.4375	140s 6½d	35.00
29	4.94500	4.93125	45.2500	20.3750	140s 6 d	35.00
30	4.94250	4.92750	45.0000	20.2500	140s 3½d	35.00
Av. for month	4.91524	.....	45.460	20.740	.....	35.00
AVERAGES FOR WEEK						
April						
7	4.89875	.....	45.975	.....	.....	.....
14	4.89896	.....	45.950	.....	.....	.....
21	4.91771	.....	45.100	.....	.....	.....
28	4.93604	.....	44.950	.....	.....	.....

Calendar week averages: New York Silver, April 3rd, 45.200; 10th, 46.275; 17th, 45.700; 24th, 44.850.
(e) No quotation (Saturday).

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout April.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1937 April	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1	71.5000	71.0000	76.0000	290.0000	287.0000	30.8750	30.8750	32.3125	32 6250
2	70.0000	69.3750	73.0000	284.5000	281.7500	30.4375	30.4375	31.3750	31.6875
5	68.6250	68.0000	72.5000	286.0000	283.2500	30.1250	30.1250	30.7500	31.0000
6	67.0000	66.5000	70.0000	283.0000	280.2500	29.0625	29.0625	30.1250	30 3125
7	63.7500	62.8750	67.0000	272.0000	270.0000	25.6875	25.6250	26.0000	26.1875
8	64.0000	63 1875	69.0000	274.7500	272.0000	27.3125	27.1250	28.1250	28.3125
9	65.8750	65.1250	70.0000	276.7500	273.5000	27.5000	27.2500	28.3125	28.5000
12	63.5000	62.5000	68.0000	274.5000	271.5000	26.5000	26.2500	26.7500	26.9375
13	62.8750	61.7500	68.5000	272.2500	269.2500	25.3750	25.1250	26.3125	26.5000
14	64.1250	62.6250	68.5000	275.7500	272.7500	25.6875	25.5000	26.1250	26.3750
15	64.1250	62.6250	68.5000	272.5000	270.0000	25.3750	25.2500	26.3125	26.5000
16	62.0000	60.8750	67.0000	265.5000	263.7500	25.0625	24.9375	26.0000	26.0000
19	59.2500	57.5000	65.0000	258.0000	256.5000	24.0625	23.9375	24.6250	24.6250
20	55.5000	53.5000	62.0000	249.0000	245.5000	23.0000	22.8750	22.3750	22.3750
21	60.5000	57.3750	63.0000	261.0000	256.7500	24.5625	24.4375	23.6875	23.6875
22	59 7500	57.2500	64.0000	269.2500	264.6250	26.1250	26.0000	25.7500	25.7500
23	60.3750	57.6875	65.0000	259.5000	255.5000	25.4375	25.2500	25.4375	25.5000
26	58.1250	55.1250	62.5000	253.5000	250.0000	24.5625	24.3750	22.8750	23.0000
27	58.2500	55 8750	61.0000	255.0000	251.7500	24.6875	24.5000	24.0000	24.0625
28	60.5000	58.1250	62.5000	256.0000	252.0000	25.0625	24.8750	24 5000	24.5000
29	57.0000	54 2500	60.5000	242.7500	239.7500	22.4375	22.2500	22.1875	22.1875
30	58.5000	56.0000	62.0000	245.5000	242.5000	23.3750	23.2500	22.8125	22.9375
Av. for month	62.506	.....	66.614	267.136	.....	26.014	25.878	26.216	26.344

CURRENT PRICES—MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(May 1, 1937)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb.	20c.
Antimony, domestic, spot, lb.	15.250c.
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	90c @$1.20
Calcium, lb., ton lots 98 @ 99 per cent	75c.
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (Official quotation) troy oz.	$55.00
Quicksilver, flask of 76 lb., 100 flasks or more	$91.00@$93.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45 @ 47 per cent, c.i.f. Atl. ports, long ton	$21.00@$21.50
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$5.25
Mesabi bessemer	$5.10
Old Range non-bessemer	$5.10
Mesabi, non-bessemer	$4.95
Lead (Galena) 80 per cent Joplin, Mo., ton	$70.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52 @ 55 per cent	42c.
49 @ 51 per cent	40c.
44 @ 47 per cent	36c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$21.00
Domestic Scheelite	$21.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$45.00

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3c
Cobalt Oxide, 70 @ 71 per cent, lb.	$1.41@$1.51
Copper Sulphate, 100 lb.	$5.40
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.34
Sodium Sulphate, bulk, ton	$13.00@$15.00

ALLOYS

Beryllium Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb.	10½c.
Ferromanganese, 78 @ 82 per cent, gross ton	$102.50
Ferromolybdenum, 50 @ 60 per cent Mo, lb. of Mo contained	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.70@$1.75

NON-METALLIC MINERALS

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@$600
Crude No. 2	$200@$225
Spinning fibers	$90@$170
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35 @.....
Cement stock	$23 @.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$7.00
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6@ $7.50
Domestic, abrasive, 70 @ 84 per cent	$12.50@$15.00
Dalmatian, 50 @ 55 per cent	(a)$5.50@$7.00
French, 56 @ 59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$6.50@$8.50
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$25.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	15@30c.
2 x 2 in.	30@50c.
3 x 3 in.	75@$1.00
3 x 4 in.	$1.00@$1.25
4 x 6 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$24.50
Basic	$23.50
No. 2 Foundry	$24.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$37.00
Structural shapes, 100 lb	$2.25
Bars, 100 lb	$2.45

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1936	1937	1936	1937	1936	1937
January	47.250	44.913	20.250	20.734	496.115	490.670
February	44.750	44.750	19.796	20.083	499.908	489.307
March	44.750	45.130	19.663	20.677	496.952	488.412
April	44.892	45.460	20.245	20.740	494.139	491.524
May	44.869	.....	20.248	.....	496.850	.....
June	44.750	.....	19.770	.....	501.817	.....
July	44.750	.....	19.590	.....	502.178	.....
August	44.750	.....	19.490	.....	502.519	.....
September	44.750	.....	19.579	.....	503.455	.....
October	44.750	.....	19.977	.....	489.755	.....
November	45.431	.....	21.050	.....	488.727	.....
December	45.352	.....	21.238	.....	490.670	.....
Year	45.087	.....	20.075	.....	496.924	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot (a)			
	Domestic		Export		Standard		Electrolytic	
	1936	1937	1936	1937	1936	1937	1936	1937
January	9.025	12.415	8.358	12.112	34.706	51.497	38.788	56.497
February	9.025	13.427	8.566	13.828	35.313	59.225	39.463	64.013
March	9.025	15.775	8.708	16.590	36.040	72.339	40.227	76.167
April	9.169	15.121	8.849	14.692	36.975	62.506	41.131	66.614
May	9.275	.....	8.819	.....	36.690	.....	40.839	.....
June	9.275	.....	8.790	.....	36.324	.....	40.357	.....
July	9.352	.....	8.993	.....	37.217	.....	41.228	.....
August	9.525	.....	9.297	.....	38.259	.....	42.375	.....
September	9.525	.....	9.523	.....	38.915	.....	43.267	.....
October	9.563	.....	9.669	.....	40.980	.....	45.295	.....
November	10.161	.....	10.349	.....	43.932	.....	48.467	.....
December	10.763	.....	10.835	.....	45.946	.....	50.364	.....
Year	9.474	.....	9.230	.....	38.441	.....	42.650	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1936	1937	1936	1937	1936 Spot	1936 3 Mos.	1937 Spot	1937 3 Mos.
January	4.500	6.000	4.350	5.850	15.397	15.494	27.272	27.150
February	4.515	6.239	4.365	6.089	16.022	16.141	28.319	28.328
March	4.600	7.190	4.450	7.040	16.608	16.767	33.027	32.979
April	4.600	6.175	4.450	6.025	16.097	16.234	26.014	25.878
May	4.600	.....	4.450	.....	15.530	15.601	.....	.....
June	4.600	.....	4.450	.....	15.170	15.259	.....	.....
July	4.600	.....	4.450	.....	15.856	15.954	.....	.....
August	4.600	.....	4.450	.....	16.772	16.859	.....	.....
September	4.600	.....	4.450	.....	18.009	17.974	.....	.....
October	4.631	.....	4.488	.....	18.446	18.375	.....	.....
November	5.114	.....	4.964	.....	21.723	21.693	.....	.....
December	5.554	.....	5.406	.....	25.560	25.503	.....	.....
Year	4.710	.....	4.560	.....	17.599	17.655	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1936	1937	1936	1937
January	47.234	50.925	209.731	229.350
February	47.962	52.010	207.081	233.750
March	48.037	63.043	213.080	282.988
April	46.963	59.172	209.313	267.136
May	46.352	.....	202.429	.....
June	42.204	.....	183.167	.....
July	43.021	.....	185.957	.....
August	42.579	.....	183.731	.....
September	44.754	.....	194.676	.....
October	44.975	.....	201.193	.....
November	51.392	.....	230.869	.....
December	51.823	.....	232.108	.....
Year	46.441	.....	204.445	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1936	1937	1936 Spot	1936 3 Mos.	1937 Spot	1937 3 Mos.
January	4.848	5.847	14.488	14.719	21.153	21.281
February	4.859	6.465	15.125	15.391	25.122	25.322
March	4.900	7.381	15.983	16.190	33.188	33.405
April	4.900	7.010	15.181	15.334	26.216	26.344
May	4.900	.....	14.536	14.777	.....	.....
June	4.880	.....	13.896	14.122	.....	.....
July	4.783	.....	13.579	13.826	.....	.....
August	4.800	.....	13.528	13.759	.....	.....
September	4.850	.....	13.906	14.159	.....	.....
October	4.850	.....	14.554	14.835	.....	.....
November	4.974	.....	16.301	16.554	.....	.....
December	5.273	.....	17.957	18.145	.....	.....
Year	4.901	.....	14.920	15.151	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1936	1937	1936	1937
January	105.000	90.000	20.000	19.500
February	105.000	90.000	20.000	19.500
March	105.000	101.667	20.000	20.000
April	105.000	105.000	20.000	20.000
May	105.000	.....	20.000	.....
June	105.000	.....	20.000	.....
July	93.462	.....	20.000	.....
August	90.000	.....	20.000	.....
September	90.000	.....	20.000	.....
October	90.000	.....	20.000	.....
November	90.000	.....	20.000	.....
December	90.000	.....	20.000	.....
Year	97.789	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1936	1937	1936	1937	1936	1937
January	12.736	14.130	76.769	90.250	36.885	50.404
February	12.967	14.563	77.000	91.000	35.000	64.360
March	13.072	16.375	77.000	91.778	34.115	58.000
April	12.673	16.043	76.731	92.000	32.846	58.000
May	12.410	.....	74.940	.....	32.000	.....
June	11.707	.....	74.192	.....	36.346	.....
July	11.245	.....	73.423	.....	39.308	.....
August	11.125	.....	73.923	.....	49.577	.....
September	11.740	.....	85.280	.....	65.960	.....
October	12.058	.....	89.240	.....	54.074	.....
November	12.233	.....	90.250	.....	48.000	.....
December	12.918	.....	90.250	.....	48.000	.....
Year	12.240	.....	79.917	.....	42.926	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quick silver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1936	1937	1936	1937	1936	1937
January	20.00	21.50	19.00	20.50	19.50	21.00
February	20.00	21.50	19.00	20.50	19.50	21.00
March	20.00	24.20	19.00	23.20	19.50	23.70
April	20.00	24.50	19.00	23.50	19.50	24.00
May	20.00	.....	19.00	.....	19.50	.....
June	20.00	.....	19.00	.....	19.50	.....
July	20.00	.....	19.00	.....	19.50	.....
August	20.00	.....	19.00	.....	19.50	.....
September	20.00	.....	19.00	.....	19.50	.....
October	20.00	.....	19.00	.....	19.50	....
November	20.23	.....	19.23	.....	19.73	....
December	21.00	.....	20.00	.....	20.50	....
Year	20.103	.....	19.103	.....	19.603	....

Iron in dollars per long ton. F. o. b. Mahoning and Shenango Valley furnaces